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SCIENCE & ENGINEERING INDICATORS

1998



The Cover

Felice Frankel, MIT Artist in Residence and Research Scientist, believes that bringing an aesthetic component to scientific imagery is one way of making science more accessible. Her photograph of Proteus colonies growing in patterns on a petri dish captures part of James Shapiro's research at the Department of Biochemistry and Molecular Biology, University of Chicago. The scale reference for the image is 5 cm.

Frankel collaborates with investigators in numerous disciplines, creating images that have appeared on the covers and pages of various journals. Her most recent collaboration is the book *On the Surface of Things* (Chronicle Books), with text by George M. Whitesides, Mallinckt-odt Professor of Chemistry, Harvard University.

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Letter of Transmittal



NATIONAL SCIENCE BOARD 4201 Wilson Boulevard ARLINGTON, VIRGINIA 22230

February 26, 1998

The Honorable William J. Clinton The President of the United States The White House Washington, DC 20500

Dear Mr. President:

It is my honor to transmit to you, and through you to the Congress, the thirteenth in the series of biennial Science Indicators reports, Science and Engineering Indicators – 1998. The National Science Board submits this report in accordance with Sec. 4(j)(1) of the National Science Foundation Act of 1950, as amended.

These reports are designed to provide a broad base of quantitative information about U.S. science, engineering, and technology for the use of public and private policymakers in their decisions about these activities.

Investments in basic research, advanced technology, and science and engineering education are critical to the achievement of our national economic and social goals of improving health, welfare, economic competitiveness, and national security. The quantitative analyses in this report provide information on a variety of critical trends and issues as we prepare to enter the 21st century.

The report presents information on science and mathematics education from the precollege level, through graduate school, and beyond; and also presents information on public attitudes and understanding of science and engineering. It analyzes science and engineering activities in the United States and provides valuable comparative information on science and technology in other countries. One of the important new features of the report is a chapter on the "Economic and Social Significance of Information Technologies." I should also note that the entire report will be available on the World Wide Web.

I hope that you, your Administration, and the Congress will find this report useful as you discuss and determine the policies and priorities for the Nation.

Respectfully yours,

Richard n. Zares

Richard N. Zare

Chairman

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The National Science Board extends its appreciation to the staff of the National Science Foundation for preparing this report.

Organizational responsibility for the volume was assigned to the Directorate for Social, Behavioral and Economic Sciences, Bennett I. Bertenthal, Assistant Director.

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Introduction: The Past Is Prologue

Maintaining a Tradition of Excellence and Innovation

For more than a quarter of a century, the National Science Board's *Science & Engineering Indicators* report series has been a chronicler of key trends in science and engineering research and education. As the United States begins the transition into the 21st century and into a knowledge-based economy, it is worthwhile to examine the significant changes in the science and technology (S&T) enterprise that characterize the current period. Many of the issues faced at the time of the Board's first report, *Science Indicators* – 1972, endure. Also, important aspects of the future will be at least partially determined by the S&T resources—both human and financial—in which the Nation has already invested.

An analysis of historical trends is possible due to the fore-sight of science policy leaders in the past. The collection and analysis of quantitative information as a basis for policy and decisionmaking was an integral component of the National Science Foundation's (NSF's) mandate from the outset. In preparing NSF's first full-year budget for fiscal year 1952, the National Science Board allocated \$1 million of its approximately \$13.5 million request for a survey of the Federal Government's financing of research and development (R&D). In 1953-54, NSF extended its surveys beyond the Federal Government to encompass research support and performance in industry, colleges and universities, and other organizations. At about the same time, it initiated the first in a series of human resource surveys.

"Through these studies," as NSF's 1957 annual report emphasized, "the Foundation has provided a new kind of measurement of national economic strength." This quote from a document published over four decades ago is as appropriate today as it was then. Many of the indicators that were developed at that time are still viewed as essential ways of measuring national S&T capabilities and economic strength. As times change, the need for additional data and indicators has evolved, along with the need for greater elaboration and disaggregation of many of the previous data trends. This information and analyses enable a better understanding of the various characteristics of the S&T enterprise, including who the various participants are, patterns of collaboration, and impacts on the broader society.

The 1957 annual report, which included a chapter summarizing NSF's survey activities and highlighting future survey plans, stressed the centrality of this work to the agency's mission. In fulfilling its statutory responsibility to develop and encourage the pursuit of a national policy for the promotion of

basic research and education in the sciences, the National Science Foundation developed and has continued its surveys of the U.S. R&D effort in various sectors of the economy. These studies and surveys provide a solid basis for analyses, conclusions, and recommendations concerning S&T resources.

Responding to Expanding User Needs

The National Science Foundation Act of 1950, as amended, states that the Board is responsible for rendering to the President for submission to Congress in each even-numbered year a report on indicators of the state of science and engineering in the United States (Sec. 4 [j][1]). The current issue, *Science & Engineering Indicators* – 1998, is the 13th in the biennial series. This important national and international data resource is part of the Board's larger responsibility in the area of national science and technology policy.

The Act further authorizes the Board to advise the President and Congress on matters of science and engineering policy (Sec. 4 [j][2]). In accord with this broader obligation, the Board has determined to prepare a series of occasional papers commenting on selected trends in the *Indicators* report to focus attention on issues of particular current and long-term concern regarding the Nation's science and engineering enterprise.

Governments at all levels and nongovernmental organizations in the United States as well as in many other countries are increasingly concerned with accountability and benchmarking activities. With the advent of the Government Performance and Results Act (GPRA), the development of reliable output and impact indicators for inclusion in the *Science & Engineering Indicators* report series has become even more important. *Science & Engineering Indicators* – 1998 provides data and information that can be useful as a general framework or source of complementary information as various organizations develop their own specific performance indicators.

The conceptualization of new types of quantitative information to characterize emerging aspects of the science and engineering enterprise and their impacts has had a significant influence on the evolution of indicators methodology itself. *Science & Engineering Indicators* – 1998 continues this tradition with a new chapter titled "Economic and Social Significance of Information Technologies." There is an increasing need to understand and communicate more effectively and efficiently the contributions and outcomes of science and technology. Measurement of the economic and social impacts of S&T is a special challenge particularly for rapidly

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developing areas epitomized by information technologies. The Board believes that this new chapter, which addresses both positive and negative aspects of information technologies, makes a significant contribution toward synthesizing and crystallizing what is currently known about this important topic.

Beginning in the late 1950s, NSF's annual reports devoted increasing attention to the international context of U.S. science and engineering, particularly following the launching of Sputnik I by the Soviet Union in October 1957. Reflecting the importance of comparative international information, Science Indicators – 1972 included data on R&D expenditures of several major foreign countries. Coverage of international topics has been enhanced with each succeeding edition of the report, as has its international readership. Noting the increase in the globalization of science and technology and the increased interdependence of the world's economies, the Board decided to make international comparisons and global trends a major theme of the Science & Engineering Indicators -1998 report. The growing availability of internationally comparable data is—in large measure—the result of close working relationships developed over many years between NSF staff and their counterparts in other countries who are also engaged in the collection and analysis of indicators data. Several multinational organizations also contribute substantially to making such data available. These include the Organisation for Economic Co-operation and Development (OECD), the United Nations Economic, Scientific, and Cultural Organization (UNESCO), the European Union (EU), the Pacific Economic Cooperation Council (PECC), the Asian Pacific Economic Cooperation (APEC), the InterAmerican InterIberian Science and Technology Network (RICYT), and the Organization of American States (OAS).

In recognition of the increasing attention worldwide to the importance of developing S&T indicators, as well as NSF's international leadership in this effort, NSF and OECD organized an international workshop on the Uses of Science and Technology Indicators for Decisionmaking and Priority Setting; this was held at NSF headquarters from September 7-9, 1997. Claudia Mitchell-Kernan, Chairman of the Science & Engineering Indicators Subcommittee, represented the National Science Board as a co-host of the meeting and stressed the growing importance of international comparisons. The representatives from 28 countries and six international organizations who participated in the event strongly concurred.

Today, the need for quantitative data to assist in decisionmaking is even stronger than it was when the Board first began this effort. The U.S. science and technology enterprise is in transition. The country is changing its priorities for R&D investment and faces budgetary constraints in many sectors. Additionally, the United States—and the rest of the world—is part of an increasingly global economy. Science and engineering activities have always had a global dimension, but this is now intensifying. Science & Engineering Indicators – 1998 not only emphasizes international comparisons, but also provides data and analyses related to all of the above important topics.

With the growth of the science and engineering enterprise

over the past decades and of public recognition of its importance to economic and social well-being, the audience for the *Science & Engineering Indicators* reports and the need for new data and analyses have expanded. To make these data more accessible to this growing audience, the entire report is now available in electronic format (<<ht>http://www.nsf.gov/sbe/srs/stats.htm>>) as well as in hard copy.

Additional New Features of This Report

In the tradition of previous reports, *Science & Engineering Indicators* – 1998 contains a number of new features and indicators. In addition to enhanced international comparisons and a new chapter on the significance of information technologies, these new features include the following:

- improved international performance indicators of precollege science and mathematics education, curricula, and teacher preparation;
- increased attention to and new indicators of international S&T mobility, such as foreign participation in the S&T activities of the Nation, international engineering programs in the United States, and the reverse flow of scientists and engineers to Asia;
- enhanced coverage of the situation of recent graduates and postdoctoral scientists and engineers;
- ♦ coverage of the restructuring of the defense industry and its impact on the Nation's S&T enterprise;
- enhanced and new indicators of intersectoral and international collaborations/partnerships;
- ♦ expanded coverage of the service sector;
- new venture capital indicators;
- new indicators of Internet and World Wide Web use;
- indicators of the impacts of information technologies on science, mathematics, and engineering education, including some attention to distance learning in higher education;
- potential future requirements for information technology employment; and
- ♦ analyses of access to the latest information technologies and their potential impact on participation in science and mathematics careers.

Another new feature of *Science & Engineering Indicators* – 1998 is the inclusion of several reflections on future pressures and possible trends, coupled with the identification of a number of important data and information gaps that deserve continuing attention.

The report Overview is organized around four cross-cutting themes that encapsulate significant trends in the transition into the 21st century. Taken together, these trends exemplify both the condition of the science and engineering enterprise in the United States and the links between science and engineering activity and U.S. society more broadly as the country prepares for a new century. These trends are:

- ♦ Increasing globalization of science, technology, and the economy. Other countries besides the United States are investing in financial and human resources for science and technology, recognizing that such investments are essential underpinnings for social and economic well-being in the global economy. Individual scientists and engineers, industrial firms, and academic institutions are taking advantage of the increasingly international character of S&T, as witnessed by the enhanced international mobility of the S&T workforce, international coauthorship of scientific publications, the development of international industrial alliances, and the global flow of technological know-how.
- ♦ Greater emphasis on science and engineering education and training. Many countries, including the United States, recognize the importance of providing an excellent education to their population in a global, knowledge-based economy. At the professional level, universities in the United States and elsewhere face the challenge of introducing greater flexibility and breadth into their curricula so as to improve the employment prospects of their students at both the undergraduate and graduate levels. More broadly, the Nation as a whole faces the challenge of ensuring that its diverse workforce will possess sufficient technological literacy, and its citizenry sufficient knowledge and understanding of S&T and its socioeconomic impacts, to address the requirements of the new century.
- ♦ Structural and priority changes in the science and engineering enterprise. The decreasing involvement of the Federal Government relative to private industry in providing financial support for the Nation's R&D effort, evident since the beginning of the decade, persists. The federal role remains essential, however, in the support of basic research in the academic sector and in the integrally linked education of the country's science and engineering workforce. Even as the role of industry in supporting R&D has become more prominent, the structure of research in industry itself is changing, as is evident from the increasing prominence of R&D in the service industries. Industrial R&D support remains most heavily concentrated in applied research and development, as opposed to basic research. That private industry recognizes the importance of U.S. colleges and universities to the national enterprise is evident from the increasing links between the industrial and academic research sectors.
- ♦ Increasing impact of science and technology on our daily lives. The impact of S&T on our daily lives is profound—however difficult to track or quantify. The changes brought about in the workplace, schools, and homes by information technologies may be the most obvious case in point. Data characterizing many of the more important effects are presented in chapter 8 of this report, "Economic and Social Implications of Information Technologies."

None of the cross-cutting themes identified as exemplary of the U.S. science and engineering enterprise in this, the penultimate edition of *Science & Engineering Indicators* in the 20th century, is particularly novel. Indeed, these themes have been apparent—at least in retrospect—in the results of the surveys that NSF has been carrying out since the 1950s. These themes will no doubt continue to be important in the year 2000 and beyond.

A Continuing Responsibility

A decade ago, it would have been all but impossible to predict, in any detail, the ubiquitousness of information technologies in our lives. By the same token, it is all but impossible to predict the effect of current S&T activity on our daily lives at the end of the first decade of the new century. One of the few predictions that the Board *can* make with any certainty is that the four cross-cutting themes described above will remain important after the turn of the century. It is also apparent that no ultimate solutions will have been found to the many important S&T-related issues that the Nation's decisionmakers and citizenry will face. Nevertheless, the thrill of discovery, the quest for knowledge, and the need to apply such knowledge to human problems will remain.

The Science & Engineering Indicators reports are intended to provide the factual information on S&T resources needed by policymakers in government, industry, and academia in weighing policy options. The National Science Board has long provided high-quality quantitative information relevant to S&T policy issues through its biennial Science & Engineering Indicators reports. The Board considers these reports to be a sturdy basis on which to build. It routinely revisits their format, the data and indicators they contain, and the implications of the trends identified. Interactions with the scientific community and the public provide opportunities to examine the implications of the data and anticipate what data and indicators will be needed in the future. The Board welcomes the opportunity to develop new and refined indicators to document the evolution of the U.S.—and global—science and engineering enterprise in the final years of the 20th century and beyond.

Overview: Science and Technology in Transition to the 21st Century

*

"The force of scientific and technological innovation is helping to fuel and shape that new economy, but its impact goes beyond. These investments have surely paid off in higher paying jobs, better health care, stronger national security, and improved quality of life for all Americans. They are critical to America's ability to maintain our leadership in cutting-edge industries that will power the global economy of the new century."

PRESIDENT WILLIAM J. CLINTON



cience, technology, and economies are becoming increasingly global. This is one of the major trends characterizing the transition into the 21st century. U.S. investments in science and technology (S&T) should be viewed in a global context. The United States and many other countries are investing in S&T capabilities, with both financial support and human resource development. Science & engineering (S&E) students and personnel are internationally mobile. Scientific and technological collaboration and alliances are increasing in both academia and industry. The most effective form of S&T transfer is "people embodied," but technological know-how is also transferred through direct investment, patenting activity, the sale of intellectual property, and trade in technology-embodied products. The following highlights demonstrate the globalization of science, engineering, technology, and the economy in terms of growth in worldwide S&T investments and increased international interactions.

Many countries are investing in science and technology as a key economic strategy.

- ♦ The U.S. economy continues to rank as the world's largest, and the United States (all sectors combined) also spends the largest amount for research and development (R&D). Similarly, most other industrialized and developing countries are investing in R&D. European countries have long done so, but now countries in Asia and the Americas are also putting special emphasis on increasing both human and financial investment in S&T.
- ♦ Expenditures on R&D performed in the United States exceeded \$200 billion for the first time in 1997. The United States accounts for about 44 percent of the industrial world's R&D investment and almost as much as the other G-7 countries (Japan, Germany, the United Kingdom, France, Italy, and Canada) combined. In civilian R&D, however, the expenditures of these six countries totaled 18 percent more than nondefense R&D spending in the United States.

S&E education is increasing globally.

♠ Many countries have invested in training scientists and engineers. From the mid-1980s to the mid-1990s, the number of degrees in higher education in science and engineering increased rapidly in Asia and Europe. Trend data from selected Asian countries show great increases in the number of first university degrees in science and engineering fields for China, India, Japan, South Korea, Singapore, and Taiwan. Between 1975 and 1995, the total number of degrees in the natural sciences earned by students from these countries doubled; those in engineering almost tripled.

- ◆ From 1975 to 1992, the Western European countries collectively more than doubled their annual production of first university degrees in science and engineering. This increase in S&E degree production occurred despite a declining pool of college-age students in Europe. Participation rates in S&E degrees increased to more than offset the declining population.
- ◆ Europe leads the United States and Asia in S&E doctoral degree production. In 1995, doctoral degrees awarded in S&E fields by Western and Eastern European (including Russia) institutions totaled 45,647—about 60 percent higher than the North American level and almost three times as many as the number recorded for Asian countries.
- ♦ The global diffusion of S&E education has implications for the U.S. higher education system. Other countries' increasing capacity to educate students in advanced levels of science and engineering may be one reason for the decline in foreign student enrollment in U.S. engineering programs. Additionally, the continuing expansion of global capacity for S&E education may affect all nations, since it indicates an increasing potential for technological and economic development worldwide.

The S&T workforce is becoming more global.

- ♦ The number of scientists and engineers engaged in research and development has increased in many countries. The U.S. share of the total numbers of R&D scientists and engineers in the G-7 has fallen slightly from 48 percent in 1981 to 45 percent in 1993. Japan had 80 scientists and engineers engaged in R&D for every 10,000 persons in the labor force in 1993, compared with 74 for the United States.
- ♠ In the past decade, foreign students have accounted for the large growth in S&E doctoral degrees in U.S. universities. For the period 1992-96, the percentage of foreign doctoral recipients planning to remain in the United States increased: more than 68 percent planned to locate in the United States, and nearly 44 percent had firm offers to do so. Stay rates differ considerably by nationality. In 1996, more than half (57 to 59 percent) of S&E doctoral recipients from China and India receiving their degrees from a U.S. institution had firm plans to stay. A smaller percentage of those from South Korea and Taiwan (24 and 28 percent, respectively) accepted employment offers in the United States.
- ♦ International mobility is a characteristic of postdoctoral researchers. From 1990 to 1994, U.S. universities provided slightly more than half of their postdoctoral appointments to non-U.S. citizens. Another indicator of international mobility is the proportion of foreign-born faculty in U.S. higher education. In 1993, 37 percent of U.S. engineering professors and 27 percent



"Science and art belong to the whole world and before them vanish the barriers of nationality."

JOHANN WOLFGANG VON GOETHE



- of U.S. mathematics and computer science professors were foreign-born. These faculty members are mainly from Asia and Europe, with the largest numbers coming from India, China, the United Kingdom, Taiwan, Canada, and South Korea.
- ♦ In 1993, almost a quarter (23 percent) of doctoral scientists and engineers in the United States were foreign-born. More than a third of these (34 percent) received their S&E doctorates from foreign institutions. In general, the percentage of immigrants is highest in fields with very good labor market conditions, such as engineering and computer sciences. The highest proportion of foreign-born holders of doctorates was in civil engineering (51 percent); the lowest was in psychology (9 percent).
- ♦ Some U.S. doctorate recipients go abroad. A lower-bound estimate of U.S.-born Ph.D. graduates residing abroad in 1995 is 13,900 (3.3 percent of the total). If those with U.S. citizenship or permanent residency at the time of their degrees are included, this rises to 19,600 (4.1 percent of the total).

Scientific publications are increasingly international in character.

- ♦ Since 1981, the overall number of articles published in a set of the world's influential S&T journals rose by almost 20 percent, compared with a rise of 8 percent in articles attributed to U.S. authors. This increase coincided with the strengthening of S&T capabilities in several world regions. Europe increased its share of published output from 32 percent in 1981 to 35 percent in 1995, reaching a higher share than that of the United States. Asia's share rose from 11 to 15 percent over the period.
- ◆ International collaboration on scientific publications is increasing, reflecting the globalization of science. In 1995, half of the articles in a set of journals covered by the Science Citation Index had multiple authors, and almost 30 percent of these involved international collaboration. A steadily growing fraction of most nations' papers involved coauthors from different nations. From 1981 to 1995, while article output grew by 20 percent, the number of articles with multiple authors rose by 80 percent, and the number with international coauthors by 200 percent. These trends affected all fields.
- ♦ For almost every nation with strong international coauthorship ties, the number of articles involving a U.S. author rose strongly between 1981 and 1995. Nevertheless, during this same period, many nations broadened the reach of their international collaborations, particularly within

"Every great advance in science has issued from a new audacity of imagination."

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JOHN DEWEY



- geographical regions, causing a drop in the U.S. share of the world's internationally coauthored articles. In the Asian region, collaboration particularly involved China and the newly developing industrial countries.
- Citation patterns also mirror the global nature of the scientific enterprise, as researchers everywhere extensively use and cite research findings from around the world. U.S. scientific and technical articles as a whole are cited by researchers in virtually all mature scientific nations in proportions greater than the U.S. share of world output in chemistry, physics, biomedical research, and clinical medicine. U.S. articles in the remaining fields tend to be cited at or slightly below the U.S. share of world output.

Industrial firms are developing international alliances.

◆ Industrial firms are using global research partnerships as a means of strengthening core competencies and expanding into technology fields that are crucial to maintaining market share. Since the mid-1980s, companies worldwide have entered into over 4,000 known multi-firm alliances involving strategic technologies. More than one-third of these were between U.S. firms and European or Japanese firms. Most of the alliances were created to develop and share information technologies.

Foreign patenting activity demonstrates the global nature of technology.

- ◆ Foreign patenting in the United States is also strong and highly concentrated by country of inventor. Five countries—Japan, Germany, France, the United Kingdom, and Canada—accounted for 80 percent of foreign-origin U.S. patents. Several newly industrialized economies, notably Taiwan and South Korea, dramatically increased their patent activity in the late 1980s and continue to do so.
- Americans successfully patent their inventions around the world. U.S. inventors received more patents than other foreign inventors in neighboring countries—Canada and Mexico—and in distant markets such as Japan, Hong Kong, Brazil, India, Malaysia, and Thailand.

Trends in royalties and fees indicate global flows of technological know-how.

♦ The United States is a net exporter of technological know-how; royalties and fees received from foreign firms have averaged three times those paid to foreigners by U.S. firms for access to their technology. Japan is the largest consumer of U.S. technology sold as intellectual property, and South Korea is the second largest.



"The world is changing more quickly than ever. Each of us sees the speed and force of those changes around us every day, in ways we perceive as wondrous, elegant and profound – even sometimes, a little overwhelming."

RICHARD N. ZARE

CHAIRMAN

NATIONAL SCIENCE BOARD



Foreign direct investments in R&D are increasing and demonstrate S&T globalization

- Substantial investment in R&D is made by U.S. firms abroad as well as foreign firms in the United States. From 1985 to 1995, U.S. firms increased their R&D investment abroad three times faster than their company-funded R&D performed domestically.
- ♠ R&D funding in the United States by foreign companies grew an average of 12.5 percent per year from 1987 to 1995, even after adjusting for inflation. Foreign-sourced R&D performed in the United States is now roughly equivalent to U.S. companies' R&D investments abroad. More than 670 foreign-owned R&D facilities are located in the United States.
- Most of the foreign international investment in R&D flowing into the United States is from Europe and Japan and is concentrated in the drugs and medicines, industrial chemicals, and electrical equipment industries.

International trade in technology products is another indicator of S&T globalization.

- ♦ The United States continues to be the leading producer of high-tech products, responsible for about one-third of the world's production of such products. During the 1980s, Japan rapidly enhanced its stature in high-tech fields, but by 1995, U.S. high-tech industries regained world market share lost during the previous decade.
- Between 1990 and 1995, three of the four science-based industries in the United States that form the high-tech group—computers, pharmaceuticals, and communications equipment—gained world market share. Aerospace was the only U.S. high-tech industry to lose market share in the 1990s. The U.S. trade surplus in software technology doubled, and aerospace technologies produced large—albeit declining—trade surpluses for the United States.

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"A nation which depends upon others for its basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill."

VANNEVAR BUSH



any countries are emphasizing science, math, and engineering education as essential to achieving economic and societal goals both now and in the 21st cen-

tury. There is an increasing realization of the importance of education and knowledge to economic growth. Such education is seen as important not only for researchers but also for a diverse, technologically literate workforce and for an educated and informed citizenry. Examining, updating, and improving the U.S. education system from K-12 through to graduate school is a major national priority as we enter the next century. Concerns have been expressed regarding the employment prospects of science and engineering graduates, and universities are examining ways to make graduate education broader, more flexible, and relevant to present and future economic demands. Current issues include the role of the Federal Government in funding graduate education, the further integration of research and education, and the importance of attracting and retaining students from all backgrounds into science and engineering fields. The following highlights provide some information on these topics.

Progress has been made in precollegiate math and science education, but more needs to be done—especially in mathematics.

- ♠ In national assessments of math and science learning, students are performing as well as, if not better than, the students of 25 years ago. Nine-year-olds and 13-year-olds are scoring higher on mathematics and science tests than they did in 1973, while performance of 17-year-olds has remained about the same.
- ◆ In the United States, there is little difference in the mathematics and science proficiency of girls compared with boys on national assessments of education progress. As of 1996, however, large differences remain at all grade levels in the achievement scores of black and Hispanic students as compared with whites and Asians/Pacific Islanders. Native Americans generally scored closer to the national average than did blacks or Hispanics, but lower than whites.
- ◆ In a 1995 international comparative study on mathematics and science achievement, U.S. students performed comparatively better in science than in mathematics and better at the fourth grade level than at the eighth grade level.
- ♦ U.S. fourth graders were significantly surpassed in science performance only by students in South Korea. Students in Japan, the Netherlands, Australia and Austria also performed well at this level. U.S. eighth grade students scored just above the international average in science, scoring lower than students from Singapore, South Korea, Japan, and the Czech Republic.



"The path to any nation's scientific and technological capability is an early, strong, and continuous math and science education for each and every student. The earlier it begins and the longer it lasts, the better for the individual and the nation."

NEAL LANE
DIRECTOR
NATIONAL SCIENCE FOUNDATION



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"Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write."

H.G. Wells



- ◆ Unlike in science, performance in mathematics at the fourth grade level in a 1995 international test showed U.S. students behind those of Singapore, South Korea, Japan, and Hong Kong. U.S. eighth graders answered just over half of the items on the mathematics assessment correctly and scored below the international average. Eighth grade students in Singapore, Japan, South Korea, Hong Kong, Flemish-speaking Belgium, and the Czech Republic performed the best.
- ♦ Since the early and mid-1980s, the proportion of students taking advanced mathematics and science courses in high school has greatly increased. These gains often include students from underrepresented groups. Nonetheless, the achievement of U.S. students in mathematics has shown only slight gains over time, and there remains a large proportion of students unable to demonstrate anything more than basic levels of knowledge, particularly at grade 12.
- U.S. mathematics and science textbooks contain many more topics and much repetition of material compared with those of other countries. In addition, there is evidence that in the United States, eighth grade mathematics is pitched at a lower level than in higher achieving countries. U.S. students are still working on "high-end" arithmetic while their peers in other countries are studying algebra and geometry.
- ♦ The vast majority of U.S. elementary school teachers earn college degrees in education rather than in specific disciplinary areas. High school teachers are much more likely than middle or grade school teachers to possess science and mathematics degrees. Teachers are also frequently assigned to teach classes outside their fields, especially in middle school. The problem is particularly acute in mathematics.

Students often need remedial math and science preparation when entering higher education, but they are succeeding in getting S&E degrees at all levels.

- ♦ As students enter college, problems in math and science preparation are obvious. The percentage of freshmen reporting a need for remedial work in math and science has remained high, particularly for women and minorities. In 1995, of those freshmen planning to major in science or engineering, over 16 percent of the males and over 26 percent of the females thought they would need remedial work in mathematics. These data are based on students' self-evaluations and may also reflect various levels of confidence.
- Nevertheless, the number of earned bachelor's degrees in S&E from U.S. institutions has increased from over 307,000 in 1981 to 378,000 in

1995. By the mid-1990s, more than 5 percent of the college-age population had completed a bachelor's degree in a field of natural science or engineering (NS&E).

- Enrollment in undergraduate programs by underrepresented minorities has increased for over a decade, and this trend accelerated in the 1990s. In 1995, however, only about 2 percent of black and Hispanic collegeage youth earned a bachelor's degree in an NS&E field.
- Total enrollment in U.S. graduate S&E programs grew for almost two decades and has now begun to shrink. Graduate enrollments of foreign students and white males have dropped. A long trend of steady increases in the enrollment of full-time graduate students whose primary source of support was the Federal Government also ended in 1995.
- At the master's degree level, science and engineering overall showed a great increase in the numbers of earned degrees throughout the 1980s, with the trend becoming even stronger in the 1990s. The recent growth is mainly in the social sciences and engineering, with relatively stable numbers in the natural sciences, mathematics, and computer sciences. The proportion of master's degrees in S&E fields earned by women and minorities has increased over the last two decades.
- The number of doctoral degrees in engineering, mathematics, and computer sciences doubled from 1985 to 1995. Much of this growth involved foreign doctoral recipients; the number of doctoral degrees they earned in S&E fields doubled from over 5,000 in 1986 to over 10,000 in 1995.

Increased attention is going to the extent to which research and education are integrated and the role of the Federal Government in supporting both R&D and graduate students.

- The Federal Government is the main source of support for graduate students via several support mechanisms. A majority of traineeships in both private and public institutions (53 percent and 73 percent, respectively) are financed primarily by the Federal Government, as are 60 percent of the research assistantships in private institutions and 47 percent in public institutions.
- The prevalence of research assistantships as the primary mechanism of support for full-time graduate students in science and engineering has increased considerably. Research assistantships were the primary support mechanism for 66 percent of the students whose primary source of support was from the Federal Government in 1995, compared with 55 percent in 1980.

"Ignorance is the night of the mind, a night without a moon or star."

Confucius

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"Perhaps the most profound discovery of the 20th century is the sudden confrontation with the depths of our ignorance."

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Lewis Thomas

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"There is no higher or

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lower knowledge, but only one, flowing out of experimentation."

Leonardo da Vinci

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"The value of achievement lies in the achieving."

ALBERT EINSTEIN

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- ♦ The National Institutes of Health and National Science Foundation are the two federal agencies that have been the primary sources of support for full-time S&E graduate students relying on research assistantships as their primary support mechanism. Nonetheless, other agencies have varying and important impacts on graduate education in specific fields.
- Research assistantships are more frequently identified as a primary mechanism of support in the physical sciences, the environmental sciences, and engineering than in other disciplines. They account for less than 20 percent in all the social sciences, mathematics, and psychology.

Graduate education is being reexamined to determine its appropriateness for labor force needs in the future.

- Although there were many changes in labor market conditions for specific science and engineering fields, overall labor market conditions were similar in 1993 and 1995. Overall unemployment rates for science and engineering Ph.D.-holders were 1.6 percent and 1.5 percent, respectively.
- ♦ For recent Ph.D. graduates, the unemployment rate went from 1.7 to 1.9 percent. Only 2.4 percent of recent science and engineering Ph.D. recipients reported working in a non-S&E job unrelated to their fields.
- ♦ Measured by the percent reporting that they were involuntarily working outside their fields (IOF rate), the disciplines where recent Ph.D. graduates were having the most difficulties in 1995 were political science (11.2 percent), mathematics (9.3 percent), sociology/anthropology (9.1 percent), geosciences (6.8 percent), and physics (6.7 percent). Recent Ph.D. graduates in the biological sciences do very well by this measure, with only a 2.8 percent IOF rate, but other measures suggest a drop in the availability of tenure-track positions for recent biological science graduates.
- Most science and engineering Ph.D.s are currently employed outside of academia. Looking at entire career histories, only a little over half of scientists and engineers—even at the doctorate level—were employed in academia at some point in their careers.
- ♦ An estimated 26,900 Ph.D.s who earned their doctorates in the preceding three years entered academic employment in 1995. But the meaning of "academic employment" has changed for these young doctorate-holders. Fewer than 45 percent had regular faculty appointments, compared with over 75 percent in the early 1970s, while the proportion in postdoctorate positions rose from 13 to 40 percent.

- Of scientists and engineers in postdoctorate positions in 1993, only 12.1 percent were in faculty positions in a tenure track in 1995; 41.6 percent were still in postdoctorate appointments. Despite this, the length of time being spent in postdoctorate positions appears only slightly greater than that reported retrospectively by those currently in mid-career.
- While most individuals in postdoctorate positions in 1995 reported additional training and other customary reasons for accepting their appointments, 17.1 percent said they were in a postdoctorate because other employment was not available. This rises to 29.3 percent in geosciences and 26.8 percent in physics.

S&E human capital development in the United States continues to show significant unevenness across socioeconomic groups.

- ◆ The number of women with doctorates in science and engineering who held academic positions increased to 52,400 in 1995. This represented a new high of 24 percent of total academic employment of these highly trained personnel. Women remained highly concentrated in the life and social sciences and psychology.
- Minority S&E Ph.D. employment in academia continued to grow, reaching 35,300 in 1995, but stayed at low levels for some groups. The 12,800 members of underrepresented groups—black, Hispanic, Native American, and Alaskan Native—accounted for 6 percent of academic doctoral scientists and engineers, up from 2 percent in 1973. Asian employment in 1995 stood at 22,500, 10 percent of the total, up from 4 percent in 1973.
- Women and members of minority groups have tended to enter academic employment at or above their share of recently awarded science and engineering doctorates. Among recent Ph.D.s in academic employment (those with doctorates awarded in the preceding three years) women and underrepresented minorities were employed in rough proportion to their share of newly awarded doctorates to U.S. citizens and permanent visaholders, Asians were represented well in excess of their share of new Ph.D.s in science and engineering (although many of these are foreign-born).
- ♦ In the overall S&E workforce, minorities, except for Asians, are still a very small proportion of employed scientists and engineers in the United States. Asians, with 4 percent of the U.S. population, represented 10 percent of all S&E workers in 1995. Blacks and Hispanics were 3.4 percent and 2.8 percent of the S&E workforce in 1995, well below their shares of the U.S. population (12 percent and 9 percent respectively). Asians, 84 percent of whom are foreign-born, are the best represented minority group



"In the highly competitive, knowledgerich, information-intensive, global
economy, every individual, no matter
what gender, color of skin, or
disability, must be provided the
opportunity and indeed encouraged to
pursue their interests and to develop
their talents in science and technology
whether it be as a career choice or to
be able to exercise full citizenship
in the technology and information
age we have entered.
Our nation can no longer afford to
underinvest in their potential or to
have science and technology-illiterate

JOHN GIBBONS
DIRECTOR
OFFICE OF SCIENCE
AND TECHNOLOGY POLICY

citizens in its democracy."



"I spend money on war because it is necessary, but to spend it on science, that is pleasant to me."

GEORGE III

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in mathematics and computer sciences, physical sciences, life sciences, and engineering, each at around 10 percent. The underrepresented minorities—blacks, Hispanics, and Native Americans—are most likely to enter social sciences and least likely to enter physical sciences.

he nation's S&E enterprise is undergoing changes Lin structure and priorities as we prepare to enter the next century. Major changes are taking place in sector roles in the funding of research and development. The proportion of the Nation's R&D funds provided by the Federal Government has decreased, but the role of the Federal Government is still essential in the areas of basic research and education. Priorities are changing, with defense R&D decreasing in importance and life sciences and health receiving increased funding and attention. The industrial sector provides a majority and increasing share of national funding for research and development. This has implications for the character of activities supported because industrial R&D is primarily concentrated in development and applied research, rather than basic research. In many countries, direct funding is supplemented by R&D tax credits and other indirect mechanisms. Science and technology are increasingly linked, and the role of partnerships and alliances has increased between sectors, within sectors, and internationally. The service sector has a more important profile than in the past. Information technologies are an important driver for the economy and are making an economic and social impact that are just beginning to be understood.

R&D funding patterns have changed substantially.

- ♠ R&D expenditures reached an estimated record-setting high of \$206 billion in 1997. The rate of R&D investment in the mid-1990s was the highest it has been since the early 1980s, a welcome contrast to the situation in the early part of the decade, when increases in R&D spending failed to keep pace with inflation.
- ♦ Most of the R&D increases have been in the industrial sector. Industrial firms now provide two out of every three of the nation's R&D dollars (an estimated \$133.3 billion in 1997) and perform three-fourths of the national R&D effort (an estimated \$151.4 billion). The major part of industrial R&D is development and applied research rather than basic research.
- ◆ Total federal R&D obligations were an estimated \$68.1 billion in FY 1997, 12 percent below the 1989 level (in inflation-adjusted dollars). The Federal Government has been steadily losing ground to industry as a source of R&D funds. In 1997, federal agencies provided 30 percent of

- all R&D funds in the United States, down from 46 percent at the peak during the defense buildup a decade ago. This decline seems to have tapered off in the mid-1990s.
- ♦ Much of this decrease is a result of defense downsizing as priorities change, as well as attempts to control the budget deficit. The Department of Defense (DOD) share of federal R&D spending has been declining since the mid-1980s from its high of two-thirds of federal funds. In 1997, for the first time since the early 1980s, DOD is expected to account for less than half (48 percent) of the federal R&D total.
- ♦ The decrease in defense funds is reflected in federal funding of industrial R&D. Between 1987 and 1997, the federal share of total industry R&D performance declined dramatically—from 32 percent down to an unprecedented 14 percent.

Growth in federal support of academic R&D has slowed.

- ♦ In 1997, an estimated \$23.8 billion was spent for R&D at U.S. academic institutions, representing 12 percent of the total national performance. Academia, however, has a much larger role in basic research, performing more than 50 percent of the nation's effort. Academic R&D activities are concentrated (67 percent) in basic research, with 25 percent in applied research, and only 8 percent in development.
- ♦ The majority of academic R&D expenditures in 1995 went to the life sciences, which accounted for 55 percent of total academic R&D expenditures. The next largest amount of academic R&D expenditures was for engineering—16 percent in 1995.
- ◆ The Federal Government continues to provide the majority (60 percent) of funds for academic R&D. Academia has experienced a slowdown in the annual rate of growth in federal support. The share of federal funding has declined in each of the broad S&E fields since 1975. The largest decline in the share of federal funding occurred in the social sciences, and the smallest declines were in computer sciences and environmental sciences.
- ♦ Federal agencies emphasize different S&E fields in the funding portfolios of academic research, and changes in federal R&D funding by agencies can have varying impacts on R&D funding and graduate education support in various fields. For example, changes in federal funding for defense R&D have affected academic engineering and computer science funding.



"Since the war years, both Congress and the different administrations have shared the conviction that support of research in the Nation's universities and industries represented an investment in the national future."

D. ALLAN BROMLEY
FORMER DIRECTOR
OFFICE OF SCIENCE AND
TECHNOLOGY POLICY





"Further increases in the rate of international and intersectoral cooperation in science and engineering are not just desirable in the current environment, they are absolutely vital."

JOSEPH BORDOGNA

ACTING DEPUTY DIRECTOR

NATIONAL SCIENCE FOUNDATION



Links are increasing between industry and academia.

- ◆ Industrial support to academic R&D has grown more rapidly than support from all other sources during the past two decades, but it still is only a fraction (7 percent) of the total.
- ◆ Industrial interaction with academia can be seen in more than just financial patterns. Coauthorship by industrial researchers has grown since the 1980s, and in particular with academia. Coauthorship between industrial researchers with researchers outside their sector rose from 27 percent in 1981 to 50 percent in 1995; about two-thirds of these collaborations involved academic researchers.
- ♦ Industrial firms are using academic research in their patent applications. The number of science article citations on U.S. patents increased from 8,600 in 1987 to 47,000 in 1996. The rise in citations held for all fields and for papers from all sectors, with the fastest growth in citations to biomedical research and clinical medicine.
- ◆ Academic patenting, especially in the biomedical fields, has increased rapidly. The number of academic patents, while small, increased more than sevenfold in just over two decades, from 250 annually in the early 1970s to more than 1,800 in 1995.

The largest increases in industrial R&D are occurring in the S&E-based industries.

- ♦ Companies classified in the electrical equipment industry experienced the largest absolute increases and the highest percentage increases in nonfederal R&D expenditures between 1991 and 1995. All of the increase occurred in the electronic components segment, which had a threefold increase in spending during this period.
- Pharmaceutical companies' R&D spending nearly tripled between 1985 and 1995. The most prominent trend in the drugs and medicines industry has been the increase in importance of biotechnology research; more than one-third of drug companies' R&D projects are primarily biotechnology related. In addition, the rapid growth of R&D dollars reflects the high cost of research directed toward developing cures and treatments for various diseases.

New funding mechanisms are gaining in prominence.

Many countries have supplemented direct funding of R&D with fiscal incentives to increase the overall level of R&D spending and to stimulate industrial innovation. Almost all industrialized countries (including the United States) allow industry R&D expenditures to be 100 percent

- deducted from taxable income in the year they are incurred, and half of the countries (including the United States) provide some type of R&D tax credit.
- ♦ The pool of venture capital grew dramatically during the 1980s and emerged as an important source of financing for small innovative firms. Very little venture capital is actually disbursed to the "struggling entrepreneur" as "seed" money. In 1995, seed money accounted for only 6 percent of all venture capital disbursements; money for company expansion constituted 42 percent.

Cooperative R&D is now an important tool in the development and leveraging of S&T resources.

- ♦ There has been a major upswing in the number of inter- and intra-sectoral and international S&T partnerships since the early 1980s. The annual number of new research joint ventures between firms has been growing, with the largest increases occurring in 1995 and 1996.
- ◆ Technology transfer activities became an important mission component of federal laboratories in the late 1980s, and more than 3,500 new cooperative research and development agreements (CRADAs) were entered into between 1992 and 1995.

The service sector has increased in prominence, and information technologies are believed to have contributed to the country's shift to a service economy.

- ♦ The nonmanufacturing sector now accounts for approximately one-quarter of all R&D investment in the United States, considerably above the proportion it held in earlier decades. This higher profile is largely attributable to the growth of the information technologies (IT) and communication industries.
- ♦ An examination of employment patterns of scientists, engineers, and technicians in a portion of the nonmanufacturing sector (wholesale and retail trade, transportation, communications, and utilities) showed a downturn in employment in 1994 from the peak in 1991. The communications industry was one of the few experiencing an increase in employment of scientists and technicians between 1991 and 1994.
- ♠ Employment in IT-producing industries is projected by the U.S. Bureau of Labor Statistics to nearly double from 1986 to 2006. This expansion is based almost entirely on expected growth in computer and data processing services. However, employment in IT hardware industries has been declining. Nevertheless, as the demand for IT jobs spreads to other industries, IT occupations are expected to double over the shorter period of

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"Once experienced, the expansion of personal intellectual power made available by the computer is not easily given up."

SHEILA WIDNALL





"The more one observes,
the more clearly does he see
that it is in the soil of pure science
that are found the origins of all
our modern industry and commerce.
In fact, our civilization is wholly
built upon our scientific discoveries."

HERBERT HOOVER



- 1996-2006. Since exact projections are always difficult, this should be taken as a general direction, not an exact level of employment.
- ♦ In the United States, software companies attracted more venture capital than any other technology area. In 1995, venture capital firms disbursed a total of \$3.9 billion, of which 20 percent went to firms developing computer software or providing software services. Medical and health-related companies were second with 14 percent. By comparison, computer-related companies received just 7 percent of the venture capital distributed in Europe in 1995 and 5 percent in 1996, and European biotech firms received even less. European venture capital is primarily in industries such as machinery and equipment, fashion and leisure products.
- Between 1990 and 1995, the U.S. trade surplus in software technology doubled, and trade in computer-integrated manufacturing technologies generated a sizable surplus. However, since 1992, the United States has had trade deficits in three areas: opto-electronics, electronics, and computers and telecommunications. Large trade deficits with several Asian economies in these three advanced technology areas now exceed the trade surpluses generated from trade with other countries.
- ♦ Both South Korea and Taiwan continue to patent heavily in communication technologies and processes used to manufacture semiconductor devices, dynamic and static information storage, and display systems, among other technologies. Both are already major suppliers of computers and peripherals to the United States. These patent data show that they continue to develop new technologies and improvements that will likely support increased presence in the U.S. and global markets.

ways. The results of science and engineering findings surround us at work and at home, but the social and economic effects are often difficult to quantify and analyze. Scientific and technological literacy are important. Science and technology skills are increasingly required in many jobs. There is an increased emphasis on accountability and the importance of public understanding and awareness of science and technology. The public should be able to understand the scientific process and be knowledgeable about science and technology discoveries in order to participate more adequately in policy discussions. The information revolution is upon us and is exceedingly difficult to track, let alone understand its myriad implications and effects—both positive and negative. As we go into the next century, it is hard to visualize how our lives will be changed.

Use of information technology is increasing in the workplace, schools, and homes.

- ♦ The real net computing capital stock in the private sector was \$155.8 billion in 1995. In many industries, the number of employees who use a computer at work is more than 50 percent; in the banking industry, it is 85 percent.
- Several comprehensive studies using a variety of data and methods indicate that there is an overall skill upgrading taking place in the labor force, a trend attributed to the greater use of IT in many occupations. Along with this increased use, the incidence of IT-related injury and employee surveillance in the workplace are on the rise, but the effects on individuals are uncertain.
- ♦ Most Americans—57 percent—use a computer at home or at work. This percentage has grown steadily during the last decade, and in 1997 fully 88 percent of college graduates in the United States indicated that they used a computer at work or at home, compared with 60 percent of high school graduates and 21 percent of individuals who did not complete high school.
- Nearly 32 million Americans have access to a home computer that includes a modem, and 18 percent of adults reported in 1997 that they had used an on-line computer service during the preceding year. This is a significant increase in home access to on-line resources since 1995.
- ♦ Nearly two-thirds of Americans with graduate education or a professional degree have a home computer with a modem, compared to 31 percent of those with a high school degree. About 41 percent of Americans with a graduate degree said that they use an on-line computer service compared to only 17 percent of those with a high school degree.



"I cannot do it without counters."

WILLIAM SHAKESPEARE
THE WINTER'S TALE, IV, III



*

"If we fail to ensure that our children have the technological resources they need to compete in an ever-changing information economy, our nation will be poorer for it."

VICE PRESIDENT ALBERT GORE, JR.

*

- ◆ Approximately 16 percent of Americans reported having access to the World Wide Web from their home computers in 1997, and 12 percent of adults sampled—representing about 22 million people—indicated that they had previously tried to find some specific item of information on the Web. Around 6.5 million Americans said they had attempted to find health-related information, and about 8.8 million tried to find some scientific information (which would have included information about the environment, space, or computers).
- ♦ The use of, and access to, information technology in the classroom is seen as an important (but not sufficient) tool to enhance education, ensure equitable access, and develop computer skills for the overall population. By 1992, 80 percent of all K-12 schools had 15 or more microcomputers for instruction. In 1996, 85 percent of all schools had access to multimedia computers, 65 percent had Internet access, and 19 percent had a satellite dish. Internet linkages are not necessarily widely accessible within schools—in 1996, only 14 percent of instructional rooms had an Internet hookup.
- ♦ In fifth grade, more than half (58 percent) of the instructional use of computers is for teaching academic subject matter. By 11th grade, less than half (43 percent) of computer-based instruction is for content; 51 percent is for computer skills training. Meta-analysis of educational studies conducted between the late 1960s and the late 1980s consistently reveals positive effects of computer-based instruction at the K-12 level. Estimates of the order of magnitude vary, but one meta-analysis of 40 studies estimated learning advantages that ranged from the equivalent of one-third to one-half of a school year for K-6 education.
- Questions have been raised over the cost effectiveness of computerbased instruction relative to other forms of instruction. Additionally, significant inequity exists in educational access to computers and the Internet. Schools whose enrollments comprise primarily minority or economically disadvantaged students have one-third to three times less access to these technologies than do schools represented by white or nondisadvantaged students.
- Concerns about information privacy are growing larger and stronger.
 Two-thirds of the public said that protecting consumer information privacy was very important.

The issues of accountability and communication with the public are drawing increased emphasis.

- ♦ About one in five Americans think they are very well-informed about new scientific discoveries and about the use of new inventions and technologies. One in four Americans understands the nature of scientific inquiry well enough to be able to make relatively informed judgments about the scientific basis of results reported in the media.
- In 1997, 75 percent of Americans believed that the benefits of scientific research outweigh any present or potential harms. Despite their positive views of scientific research, Americans are deeply divided over the development and impact of several important technologies, including nuclear power and genetic engineering.
- American adults express a high level of interest in new scientific discoveries and in the use of new inventions and technologies. The public is interested in knowing what is happening in science and technology, and the scientific community needs to communicate its work ever more clearly and effectively.



"Public opinion is everything. With public sentiment nothing can fail; without it, nothing can succeed."

ABRAHAM LINCOLN



Chapter 1 Elementary and Secondary Education

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Highlights

INTERNATIONAL COMPARISONS

- ♦ In a 1995 international comparative study on mathematics and science achievement, U.S. students performed comparatively better in science than in mathematics and better at the fourth grade level than at the eighth grade level. U.S. fourth graders were significantly outperformed in science only by students in South Korea. The United States performed least well, when compared with other nations, in grade eight mathematics.
- ♦ When compared with other countries, U.S. mathematics and science textbooks contain many more topics and much repetition of material. For example, U.S. general mathematics textbooks for eighth grade students contain an average of 36 different topics, compared with 8 topics in Japanese and 4.5 topics in German texts. In addition, there is evidence that in the United States, eighth grade mathematics is pitched at a lower level than in higher achieving countries. While U.S. students are still working on "high-end arithmetic," their peers in other countries are studying algebra and geometry.

STUDENT PERFORMANCE

- ♦ In national assessments of mathematics and science learning, students are performing as well as—if not better than—the students of 25 years ago. Nine-year-olds and 13-year-olds scored higher on mathematics and science tests in 1996 than they did in 1973, while performance of 17-year-olds has remained about the same. However, little of the overall improvement in test scores that occurred during this period has come about during the 1990s.
- ♦ There is little evidence of a difference in the mathematics and science proficiency of girls compared with boys on national assessments of educational progress. The slight difference that has been identified is confined to students in the 12th grade.
- ♦ As of 1996, large differences remain at all grade levels in the achievement scores of black and Hispanic students as compared with whites and Asians/ Pacific Islanders. Native American students generally scored closer to the national average than did blacks or Hispanics.

CURRICULUM AND INSTRUCTION

- ♦ There have been large gains in the proportion of students taking advanced mathematics and science courses in high school since the early and mid-1980s—gains that often include students from underrepresented groups. In the class of 1994, close to 70 percent of students had completed geometry, 58 percent completed algebra 2, and 9 percent took calculus. Over 90 percent of seniors completed biology, over half completed chemistry, and about one-quarter took physics.
- ♦ Internet access in schools has increased substantially in recent years. As of fall 1996, 65 percent of public schools reported access to the Internet, a gain of 30 percentage points over 1994 figures. Internet access was more likely in secondary than in elementary schools, in more affluent than less affluent schools, and in schools with low to moderate minority enrollments than in schools with high minority enrollments.

TEACHERS AND TEACHING

- ♦ The vast majority of elementary school teachers earn college degrees in education rather than in specific disciplinary areas. High school teachers were much more likely to possess science and mathematics degrees: 41 percent had earned a degree in mathematics, compared with just 7 percent of middle school teachers. In science, 63 percent of high school science teachers and 17 percent of middle school science teachers possessed a science degree.
- ♦ Many middle school mathematics and science teachers fall short in meeting recommendations for coursework preparation made by national associations of teachers. Only 7 percent of middle school mathematics teachers have taken courses in all of the recommended areas and about one-third have completed none of the coursework recommendations. Forty-two percent of middle school science teachers meet the science recommendations in full.
- ♦ All too frequently, teachers are assigned to teach classes outside their fields. The problem is particularly acute in mathematics. In the 1990/91 school year, 27 percent of students in grades 7 through 12 had a mathematics teacher without at least a minor in mathematics or mathematics education. Out-of-field teaching is more common at middle schools than high schools.

Introduction

Chapter Background

Educators in elementary and secondary schools across the nation are struggling to improve and redesign mathematics and science education so that all students are well-prepared for the beginning of a new millennium. Policymakers are confronted with growing determination that a solid foundation in mathematics, science, and technology is essential not only to the economic but also to the social well-being of the nation. Indeed, a task for today's policymakers, parents, and communities is to ensure that all students are graduated from high school with a quality education that will enable them to contribute productively to society. Toward this end, the United States has set, as a matter of national policy, the goal of its students being first in the world in mathematics and science achievement by 2000.

However, national and international indicators of educational progress suggest that the country is still far from its goal, despite a growing reform movement aimed at achieving excellence and equity in education. Unresolved issues concerning the performance of students and teachers, the quality of instructional materials and teaching, and access to quality education for all students are matters still very much at the center of local, state, and national education agendas. Nevertheless, indications of forward movement abound: students are taking more advanced courses in science and mathematics, teachers are more aware of the need to change their conceptions of teaching and learning, and student achievement in mathematics and science has largely returned to or exceeded the levels set in the 1970s.

The spark for much of the current reforms came from early work in setting standards performed by professional associations of mathematics and science educators. In mathematics, the National Academy of Sciences laid out the broad outlines of mathematics reform in Everybody Counts: A Report to the Nation on the Future of Mathematics Education (MSEB 1989). The National Council of Teachers of Mathematics (NCTM) followed with two reports that made more specific recommendations—Curriculum and Evaluation Standards for School Mathematics (NCTM 1989) and Professional Standards for Teaching Mathematics (NCTM 1991).

During this same period, consensus on new directions for science education was beginning to develop, though actual national standards were some years away. By 1993, the American Association for the Advancement of Science had issued two publications, *Science for All Americans* (AAAS 1989) and *Benchmarks for Science Literacy* (AAAS 1993), and the National Science Teachers Association produced *Scope, Sequence and Coordination of Secondary School Science* (NSTA 1992). These reports, as well as others, led to a national dialog on science standards resulting in the National Academy of Sciences' *National Science Education Standards* (NRC 1996).

The standards for mathematics and science education share many core ideas: high expectations for all students; in-depth study and understanding of core concepts; emphasis on handson tasks that promote active engagement with the subject matter; and a strong focus on reasoning, problem solving, and the ability to apply learning within broader contexts.

The standards in both subjects view teachers as the critical agents that enable students to meet these more demanding levels of performance. However, a large proportion of current mathematics and science teachers were trained when conceptions of teaching and learning were very different from today. Consequently, both sets of standards emphasize the importance of professional development for teachers. Previously offered as a sporadic set of brief workshops to train teachers in specific skills, professional development is now portrayed as a career-long process of continuously updating teachers mathematics and science knowledge and teaching skills (Darling-Hammond 1994a). And although some school systems, schools, and teachers have begun to adopt practices consistent with the standards, mathematics and science educators recognize that full implementation of standards-based reform will take much more time (Jones et al. 1992; Lindquist, Dossey, and Mullis 1995; and NSF 1996).

Like professional development, equity remains an important challenge for educational reformers in mathematics and science education. At its base, equity means that each and every student has access to quality education regardless of background, race, ethnicity, or location. Some of the building blocks for equity are:

- the necessary materials, funding, and resources for standards-based learning to thrive in schools;
- ♦ fully qualified teachers who are knowledgeable about the subjects they teach; and
- appropriate instructional strategies, curricula, and tools for assessing student performance (Darling-Hammond 1992).

One of the critical issues currently facing educators is how to achieve equity and excellence amid the complexities born of an increasingly diverse national makeup. Of the 45 million children enrolled in elementary and secondary schools in 1994, approximately 15 million are ethnic or racial minorities and 6 million come from homes where English is not the primary language spoken (NCES 1996b).

There are still more challenges: how to make effective use of the information technologies that are now commonplace in homes and workplaces as tools for reforming education and improving teaching and learning productivity; how to ensure consistency in approach and quality among instructional materials, teaching, assessment of student learning, and policies formed at district or state levels; and, finally, how to continue learning how to improve—and what works and doesn't work in improving—the quality of education.

Clearly, the role education plays in our personal lives and in the nation's well-being has grown over the years. And the challenges in mathematics and science education—and in all school subjects, for that matter—are before us as educators, students, parents, and community members. And although these challenges may differ from those of years past, it is not clear that there are necessarily more of them, nor is it certain

that they are any more daunting than they once were. It may be that we are more concerned and know more about mathematics, science, and technology education in this nation than we did 20 or 30 years ago. As shown in this chapter, what *is* certain is that we have a stronger research base and a deeper, more far-reaching set of national and international indicators of performance than ever before. (See "Measuring the Performance of the Education System.")

Chapter Organization

This chapter is organized into three main parts: first, a detailed description of student achievement in mathematics and science is provided; second, curriculum and instruction are examined; and third, teachers and teaching are addressed. These latter two parts are presented because they are the components of the education process thought to have the greatest direct influence on student achievement. The chapter concludes with a summary of trends in these three areas and an interpretation of what this may mean for educational progress.

Under the student achievement section, the performance of U.S. students in both national and international contexts is examined in order to address the following questions:

- ♦ Have mathematics and science achievement in the United States improved in the last decade or more?
- ♦ Is the achievement of all students, regardless of demographic group, improving?
- ♦ How have the coursetaking patterns of U.S. students changed in the last decade and with what effects on achievement?
- How do U.S. students compare with students in other nations in mathematics and science achievement?

The second major section of this chapter, on curriculum and instruction, focuses on the following questions:

- How do the mathematics and science curricula experienced by U.S. students compare with curricula in other countries?
- ♦ What are the similarities and differences in the instructional practices and resources used in U.S. and other classrooms?

The third major section of the chapter examines the background of U.S. mathematics and science teachers in national and international contexts. The discussion centers on these questions:

- ♦ Are teachers well-prepared for teaching mathematics and science?
- What are teachers' views about teaching mathematics and science?
- ♦ What effect is the standards-based reform movement having on the profession of teaching?

Many national and international data sources—all based on national probability samples—have been mined in writing this chapter. The first section of this chapter can be examined from a number of perspectives using a variety of data sources. The discussion here draws on three primary sources: the National Assessment of Educational Progress (NAEP), the Third International Mathematics and Science Study (TIMSS), and the High School Transcript Studies. NAEP is a reliable indicator of achievement for U.S. students. Since the early 1970s, NAEP has conducted trend assessments every two years covering mathematics, science, reading, and more recently, writing. These assessments draw on nationally representative samples of 9-13-, and 17- year-olds. To date, eight trend assessments have been conducted in mathematics and nine in science.

NAEP also conducts subject matter assessments periodically on a wider range of subjects including history, geography, civics, computer competence, art, and music. Subjects are covered on a rotating basis so that in one assessment, the focus may be on mathematics and science, and in the next, on history and social studies. These assessments draw on nationally representative samples of students in grades 4, 8, and 12 rather than the age groups used in the trend studies. Items in the periodic subject matter assessments are revised from time to time to incorporate new assessment strategies and reflect prevailing professional judgments about what students in a particular grade should be learning. The items used in trend assessments are fixed, so that performance in basic areas of skill and knowledge can be traced over time, even as curriculum emphases change. Results of these two kinds of NAEP assessments are not directly comparable because of these sampling and content differences.

The second source of student performance data used in this chapter, TIMSS, compares the mathematics and science achievement of elementary and secondary students in the United States with the achievement of students in other countries. TIMSS was conducted in 1994-95 by members of the International Association for the Evaluation of Education. It is the largest and most ambitious undertaking of its kind. Fortyfive nations took part in TIMSS at the middle school level (seventh and eighth grades), and 27 at the elementary school level (third and fourth grades). 1 Achievement data and background information were collected from students in each country. Teachers and principals supplied information about instructional resources, practices, staffing, course content, and views of mathematics and science teaching. Curriculum guides and textbooks from 46 nations were analyzed to provide information on the content and skills students in different countries are expected to learn in each grade. Mathematics lessons were videotaped in a sample of eighth grade classrooms in the United States, Japan, and Germany to document differences and similarities in the content presented and the instructional approaches used.

TIMSS results have been published in several reports. Results of curriculum studies are presented in three reports: A Splintered Vision: An Investigation of U.S. Science and Mathematics Education (Schmidt, McKnight, and Raizen

¹At the time this chapter was written, 12th grade TIMSS results had not been released.

Measuring the Performance of the Education System

Few countries have a truly unitary national education system. Many are aggregations of smaller (e.g., regional) subsystems coordinated by an overall national entity. Most of the 49 countries that participated in TIMSS, for example, have fewer than five subsystems. In the case of some nations—such as the United States—these subsystems (i.e., states) are more or less autonomous, with only indirect influence exercised at the national level (Schmidt, Raizen et al. 1997).

Schmidt, Raizen et al. point out that policymaking is affected by the degree of complexity within the national education system. Countries with a unitary system can make policy about curriculum and decisions about system performance measurement with greater ease than countries with more complex, decentralized systems (Schmidt, Raizen et al. 1997).

The U.S. educational "system," then, is more accurately a multiplicity of systems that can be described from numerous perspectives. It is useful to keep various dimensions simultaneously in mind when thinking about how to measure its performance. Decisions about learning practices are made and affected by networks of practitioners, researchers, policymakers, parents, and community and business leaders, as well as by students. Decisions about what to teach are reflected in curriculum frameworks and materials, instructional practices, teachers' professional development, and student performance assessments. Decisions about resource use are shared by several levels of government: federal, state, and local—within which are school districts, schools, grade levels, and classrooms—across a country of 268 million people.

The states are the primary agents of education as delegated by the U.S. Constitution. However, a long tradition of local decisionmaking authority about what and how to teach is distributed among parent and teacher groups and school boards for each autonomous school district. No matter how the system is portrayed, the difficulty in measuring it is based in its complexity—a web spanning the nation woven within the boundaries of individual states and communities in the form of people, places, behaviors, and ideas.

Compared with countries around the world, the U.S. education system is distinguished by its size, organization, and—above all else—the diversity of the students it serves. In the 50 states and 11 territories, there are over 14,000 school districts and 87,000 public schools (NCES 1996b).

While trends in student performance and coursetaking, characteristics of curriculum and instruction, and preparation and qualifications of teachers may describe the condition of various elements of the system, they do not necessarily encapsulate the performance of the elements as they interact, work in tandem, or change across the system. How much and in what direction the system components move together (or co-vary), is an indicator of systemwide change (Chubin 1997).

The demand is increasing for valid and reliable indicators in accounting for the use of public resources and in sharing knowledge with parents, educators, and policymakers.

Many of these "systemic" features are affective or qualitative, such as system leadership, partnerships, alignment of policies and practices, and student and teacher creativity. Such systemic qualities have not yet been adequately operationalized into acceptable indicators of a system's performance.

Consistent with this systems notion, the Consortium for Policy Research in Education has developed a potential model for evaluating systemwide change in the context of a Philadelphia reform project sponsored by a large collection of public and private funders. The evaluators have created a scorecard that allows them to make judgments about the degree of change across various elements of the Philadelphia reform, thus enabling them to portray the movement of the system as a whole (CPRE 1996).

New approaches to measurement and measurement tools will be needed to investigate the synergy (or lack thereof) among system components. What is needed are indicators of how these various elements work together or apart, what factors characterize the system, and what their effects are on student achievement. Indeed, NSF has funded several research studies that support these new measurement directions. One such study, performed by Cohen and Hill (1997), has examined the interrelationship among teacher professional development, the use of curriculum materials, and the assessment of student performance in fourth and eighth grade mathematics classes in the state of California. What they found supports the power of measuring the combined effects of system components.

Cohen and Hill found that teachers who participated in professional development based on curriculum materials relevant to reform goals were much more likely than other teachers to report teaching practices aligned with these goals. Moreover, their results suggest that "when educational improvement is focused on learning and teaching academic content, and when curriculum for improving teaching overlaps with the curriculum and assessment of students, teaching practice and student performance are likely to improve" (Cohen and Hill 1997). In other words, Cohen and Hill have begun to measure the synergy among system elements as they relate to instructional materials—and have found evidence that such synergy results in improved student performance.

In general, the U.S. curriculum is not consistent with those of other countries that performed well on the TIMSS assessment. When compared with other countries, U.S. mathematics and science curricula are less focused and include far more topics than is common internationally. The topics—especially in mathematics—tend to remain in the curriculum for more grade levels than is the practice in other countries (Schmidt, McKnight, and Raizen 1997).

The Cohen and Hill study, TIMSS, and other studies supported by NSF are indicative of the research that is needed to address systemic issues. Indeed, much of the TIMSS data is yet to be analyzed, and the richness of the study holds forth the promise of more lessons to be learned. More research on systemwide change in larger and different settings is needed to advance and refine these findings.

This chapter begins to move in the direction of examining systems, both national and statewide, of mathematics and science education at the elementary and secondary level. The various measures of student performance, however imperfect, provide some evidence of system outcomes. There are still many more indicators to be developed that will aid local decisionmakers, state and federal policymakers, educators, parents, and their community partners. Although we do not yet have all of the desirable information, we have much more than we once did, more in mathematics and science than in other subject areas, and more at the elementary and secondary levels than at the postsecondary level and beyond.

1997) and two volumes—one for mathematics and one for science—that present international comparisons, *Many Visions, Many Aims* (Schmidt, McKnight et al. 1997; and Schmidt, Raizen et al. 1997). International achievement and survey results are available in four volumes, one for each subject by grade (Beaton, Mullis et al. 1996; Beaton, Martin et al. 1996; Martin et al. 1997; and Mullis et al. 1997). Results from the survey of eighth grade U.S. teachers are presented in *Mathematics and Science in the Eighth Grade* (Williams et al. 1997). Syntheses of U.S. findings from component TIMSS studies are published in two volumes of *Pursuing Excellence*, one for fourth grade (NCES 1997c) and one for eighth grade (NCES 1996c).

A third major source of information about student performance is the 1994 High School Transcript Study, which is based on the records of over 25,000 seniors who graduated from high school that year. The transcript study reports information such as the mean number of credits earned in each subject field and the percentage of students earning a given number of credits in particular subjects (NCES 1997e).

The discussion of curriculum and instruction is based largely on data from the TIMSS curriculum analyses, video observational studies, and teacher questionnaires. The technology portion of this section is drawn from a recent survey on the status of advanced telecommunications in public elementary and secondary schools (NCES 1997a).

The third section of this chapter, on teachers and teaching, is based on comparisons of data from the TIMSS teacher questionnaires with results from the National Survey of Science and Mathematics Education (NSSME) conducted during the 1993/94 school year (Weiss, Matti, and Smith 1994). NSSME, which was initiated in 1977 and updated in 1985, is one of the most comprehensive sources of detailed information on the preparation and classroom practices of mathematics and science teachers. The discussion of teacher qualifications is supplemented by data from questionnaires administered as part of the 1993/94 Schools and Staffing Survey. (See NCES 1996a.) Information on teachers' efforts to implement educational standards in their classrooms is drawn from a school reform survey conducted in spring 1996 (NCES 1997d).

Student Achievement

Trends in U.S. mathematics and science achievement are mixed, but somewhat positive on the whole. Students are more often taking advanced courses in both subjects, and their performance is slightly improved from, or no worse than, the performance levels set in the 1970s. Larger shares of students—including those from underrepresented racial and ethnic groups—are meeting basic levels of proficiency in both subjects than in past years, although wide gaps in achievement remain between students from these groups as compared with whites and Asians. (See "Do Policies and Socioeconomic Factors Play a Role in Achievement?")

Several studies have attributed differences in mathematics and science achievement to the types of courses students com-

Do Policies and Socioeconomic Factors Play a Role in Achievement?

Performance differences among states may reflect any number of factors, including differences in educational policy and in demographic characteristics. The 1996 Policies and Practices Survey, conducted by the Council of Chief State School Officers, provides information on several useful indicators of instructional quality: number of mathematics and science credits required for graduation, status of standards implementation, and requirements for teacher licensing (CCSSO 1996). An examination of these variables revealed no systematic patterns that might account for performance differences among states.

In the area of social and economic factors, there are suggestions from some studies that differences in "opportunity" may be linked to differences in student background and other socioeconomic variables. Several studies have shown that poor and minority students are more likely to attend schools with severely limited resources and less well-prepared teachers, more likely to be sorted into low academic tracks that limit their access to advanced mathematics and science courses, and less likely to attend schools that offer these advanced courses (Oakes, Gamoran, and Page 1992).

Performance in mathematics and science may also be influenced by other demographic characteristics such as family background. A study that examined the relationship between increases in achievement and changes in family characteristics in the 1980s found that gains made by white students could be completely accounted for by improved family circumstances over the years examined, but only one-third of the gains made by black students—and virtually none of the gains made by Hispanic students—were explained by these factors (Grissmer et al. 1994).

plete (Jones et al. 1992 and Gamoran 1986). Acting on the premise that more high-level courses will result in higher achievement, many states and school districts raised graduation requirements in mathematics and science (as well as in other core subjects) following publication of *A Nation at Risk* by the National Commission on Excellence in Education (1983). Two years before its release, only nine states required two or more years of science and two or more years of mathematics. Fifteen years later, 42 states had put these stricter graduation requirements into place (CCSSO 1996).

Comparisons of U.S. achievement with that of other countries provide another important perspective on how well students and schools are performing. International comparisons reveal that, although U.S. students are performing relatively well in science compared with the rest of the world, there remains much room for improvement in mathematics. The

performance of students in high-scoring nations demonstrates what is possible for students to achieve at the elementary, middle, and high school levels in this or any country. And, in so doing, student performance overseas provides information educators and policymakers can use in setting appropriate policies, expectations, and goals. Unfortunately, there is no reliable way to determine if the U.S. standing has improved or worsened in recent years. Comparisons with earlier assessments cannot be made because of methodological differences between the studies, differences in the content tested, and changes in countries participating in these tests. (For further information on performance assessments in general, see "Assessing Student Performance."

Science Coursework

High school graduates in the 1990s are much more likely to have completed advanced courses in the sciences such as biology, chemistry, and physics. In 1994, 93 percent of graduates had taken biology compared with 77 percent of 1982 graduates. Similarly, more than half now take chemistry compared with less than one-third in 1982, and one in four now complete physics compared with about one in seven in 1982. Although they remain a minuscule fraction of the total, the proportion of students completing advanced placement courses in these science subjects has also increased.

Female graduates are more likely to have taken biology and chemistry in high school than male students, but less likely to have taken physics. This represents a change in the coursetaking patterns of young women as compared with young men. In 1982, female graduates were about as likely as males to have taken chemistry and substantially less likely than males to have taken physics. (See figure 1-1.)

Students from racial and ethnic groups underrepresented in science made substantial gains in the proportions taking advanced science courses. More than 90 percent of blacks, Hispanics, and Native Americans now complete high school having taken biology. In chemistry, the proportion of blacks completing the course doubled (from 22 to 44 percent), rates for Hispanics nearly tripled (from 16 to 46 percent), and completions by Native Americans rose by more than half (from 26 to 41 percent) between 1982 and 1994. Similarly, progress was made in physics coursetaking between 1982 and 1994, although the proportions of students from black and Hispanic groups remain less than 20 percent. The proportion of blacks taking physics almost doubled, and the percentage of Hispanics nearly tripled. No discernible increase in the proportion of Native Americans completing physics was detected over the 12-year period. All in all and despite the progress, there remains a substantial gap in the proportions of blacks, Hispanics, and Native Americans who take chemistry and physics compared with Asian Americans/Pacific Islanders and whites. (See figure 1-2.)

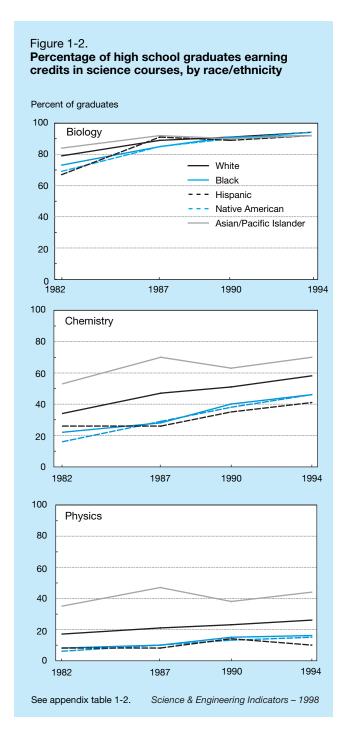
Figure 1-1. Percentage of high school graduates earning credits in selected science courses, by sex Percent of graduates 100 Biology Male Female 60 Chemistry 40 20 1987 1990 1994 1982 See appendix table 1-1. Science & Engineering Indicators - 1998

Science Proficiency

In the 1970s, science proficiency scores of elementary and secondary students remained largely flat, but—beginning in the mid-1980s—students began to show improvement. (See figure 1-3.) By the mid-1990s, 9-year-olds and 13-year-olds were scoring slightly higher than their counterparts of 1973, and the scores of 17-year-olds had rebounded to the higher 1973 levels.

Of all school subjects, science in particular has been a sticking point in comparisons of student performance between sexes and among racial and ethnic groups. The underrepresentation of women in the science, mathematics, and technology workplace makes sex-based achievement differences a continuing concern among educators. However, national assessments of educational progress reveal that there are no real differences in science proficiency between 9-year-old girls and boys. Thirteen- and 17-year-old boys edge out girls in science performance, but this difference is small and has narrowed for 17-year-olds since the early 1970s. (See appendix table 1-3.)

Of much more compelling concern at the moment are the racial and ethnic differences that remain in science achievement. The performance of black and Hispanic students at all age groups was far below that of whites in 1996, as has been the case for decades. And although the difference between black and white students has declined for 9-year-olds and 13-year-olds since the 1970s, the disparity for 17-year-olds remains virtually unchanged. There has been no change in the difference between Hispanic and white achievement at any age. Average test scores of Native American students based on a related 1996 science assessment were closer to the



national average than is the case for black and Hispanic students. Lower achievement is thought to be one reason why minority students make different elective course choices or are screened out of opportunities for more advanced study in science (Oakes 1990).

It is also useful to examine achievement differences across states. Science proficiency was reported on a state-by-state basis for the first time in 1996. (See "The Making of a New Science Assessment.") Figure 1-4 shows how eighth grade students in each participating state compared to the national average. In general, most of the high-scoring states were in

Figure 1-3. National trends in average NAEP scale scores in science at ages 9, 13, and 17 Average scale score 325 Age 17 300 275 Age 13 250 Age 9 225 1970 1973 1977 1982 1986 1990 1992 1994 1996 NOTE: NAEP is the National Assessment of Educational Progress. See appendix table 1-3. Science & Engineering Indicators - 1998

the Central, Western, and New England regions of the country, while the majority of the lower performing states were in the Southeast.²

Across states, racial and ethnic differences in science proficiency were apparent, and these cross-state differences followed many of the same patterns as overall state-by-state test score differences. That is, students of all races and ethnicities tended to score more highly in states with high overall science performance than in states with consistently lower performance. However, the magnitude of the difference in average scores varied to a surprising degree from one state to another. Average science scores for Hispanic and black populations, for example, fluctuated enormously across different states.

Black students scored below the national average in science in all states. Blacks scored highest in Colorado, but this score was not as high as even the lowest average for whites of any state. The largest achievement gaps between black and white students were in Wisconsin, Connecticut, and New York. With the exception of New York, Hispanic students in states known for their large Latino populations—California, Texas, Florida, and New York—achieved the national overall average score for Hispanic science proficiency.

²States were classified as follows (Reese et al. 1997):

Northeast—Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and (Northern) Virginia;

[♦] Southeast—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, (Southern) Virginia, and West Virginia;

Central—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; and

West—Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming.

The Making of a New Science Assessment

In 1996, in order to better measure the effects of current approaches to science education, the U.S. Department of Education made major changes to subject matter assessment in science through its National Assessment of Educational Progress. The new test represents a departure from earlier ones both in the science that is tested and in the way it is tested. First, factual knowledge is assessed within meaningful scientific contexts. Second, level of performance depends not only on knowledge of facts, but also on the ability of students to integrate this information into a larger body of knowledge, and the capacity of students to use the reasoning processes of science to develop their understanding of the natural world.

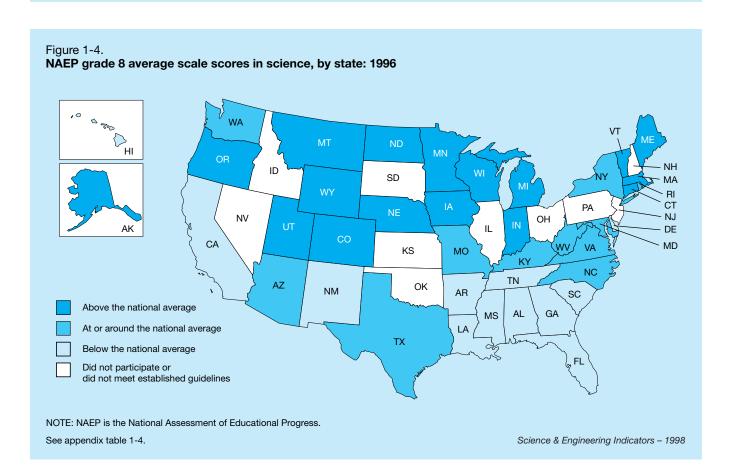
The 1996 assessment used a variety of methods for measuring student performance:

multiple-choice questions that assess students' knowledge of important facts and concepts and that probe their analytical reasoning skills;

- ♦ written response questions that explore students' abilities to explain, integrate, apply, reason about, and communicate scientific information; and
- ♦ hands-on tasks that measure students' abilities to make observations, perform investigations, evaluate experimental results, and apply problem-solving skills.

The framework from which the assessment was constructed was developed through a consensus process that brought together science teachers, curriculum experts, other educators, policymakers, members of the business community, and the general public. The framework divides science into three major fields: earth, physical, and life sciences. It also assesses such mental processes important for scientific thinking as conceptual understanding, practical reasoning, and investigation by experimentation.

Although the changes introduced in 1996 mark a meaningful and rich new source of information on student performance, comparisons cannot be made with results of earlier assessments. Consequently, this chapter relies on the NAEP trend assessments in science in making comparisons of student performance over time.



Assessing Student Performance

Assessment—in the educational context—is the *process* of gathering evidence about a student's knowledge of, ability to use, and disposition toward some subject matter with the purpose of making inferences from that evidence for a variety of ends. A test is a measuring *instrument* for evaluating and documenting those outcomes. Simple enough to describe, assessments are not simple to devise nor have they proven easy to integrate effectively within the instructional programs of large education systems. At their conceptual base, assessments are a complex endeavor and the inferences that can be made from them for individual students, teachers, schools, as well as whole educational systems need to be considered with numerous caveats.

There are differences of opinion among educators, researchers, and policymakers about the design and use of standardized and performance-based assessments.

Traditional standardized tests—usually of the short answer variety that are administered, scored, and interpreted in a consistent manner wherever and to whomever given are the tests that are most often now in place in states and at the national level. But they do not necessarily measure well those aspects of learning such as creativity, deep conceptual understanding, and the ability to apply learning in a number of contexts deemed important or appropriate by many of today's educators. Traditional tests of student performance (answering a question with a single correct short answer) are an efficient method to assess large numbers of students at low cost. However, traditional, norm-referenced, multiplechoice tests are criticized for not adequately measuring complex cognitive and performance abilities. Moreover, they have often been used to limit students' access to further learning opportunities (Darling-Hammond 1991, Glaser 1990, and Oakes 1985).

There are a variety of classroom, school and school district, state, and national tests used for numerous purposes. Their assessment functions include the following:

- 1. To make decisions about the performance of individual students and comparisons among students.
 - ◆ To determine the level or degree of attainment in a specific content area or in a body of content, as a

diagnosis of individual strengths and weaknesses in a content area, and as a readiness indicator to determine if an individual has attained the requisite levels of understanding deemed necessary for continued study in a given content area (Bresica and Fortune 1988).

- ◆ To make decisions about student promotion from grade to grade, placement in remedial or advanced level course tracks and for graduation from one educational level to the next (Madaus and Tan 1993).
- To improve instruction and learning outcomes for students and to inform students, parents, and teachers about student, classroom, school, or district progress over time (Madaus and Tan 1993).
- 3. To hold educational systems accountable for performance, to make statewide decisions about the allocation of educational resources and interventions, and to assist policymakers and researchers in making evaluative judgments about the performance of existing educational programs and practices or the need for new ones (Madaus and Tan 1993).

The National Assessment of Educational Progress has been conducted in mathematics and science learning since the late 1960s and early 1970s. NAEP uses a formal, systematic procedure to obtain a sample of students' knowledge over time and to make generalizations about how student populations are performing. NAEP has attempted to add performance items to its assessment approach in order to assist in measuring not only students' knowledge of mathematics and science, but also their ability to apply that knowledge and to articulate various aspects of problem solving.

Numerous alternative assessment experiments are being implemented and debated in schools and communities across the nation. Different testing alternatives include performance tasks, open-ended questions, portfolios, observation, and student journal writing and self-assessment.

In recent years there has been a conceptual shift in some research and policy circles as to what constitutes "good" assessments of achievement. Some current trends in measuring and analyzing student performance include:

Notwithstanding the substantial cultural differences and variations in geographic settling patterns across these states and within the U.S. Hispanic population, it was most often in Southeastern states that Hispanic student achievement lagged farthest behind. The largest differences between averages for Hispanics and whites were found in Connecticut, New York, and four Southeastern states. (See appendix table 1-4 for science achievement scores for Asians/Pacific Islanders and Native Americans.)

U.S. Science Proficiency in an International Context

In the recent international comparative study on mathematics and science achievement (TIMSS), U.S. students performed better in science than in mathematics and better at the fourth grade than at the eighth grade level. U.S. fourth graders performed very well on the science assessment—they answered 66 percent of the science items correctly (compared with the international average of 59 percent). The only nation to score significantly higher was South Korea. (See figure

- greater emphasis on assessing higher order thinking skills and processes;
- comparing student performance with established standards;
- making the assessment process public, participatory, and dynamic and including students as active participants in the assessment process;
- ensuring that all students have the opportunity to achieve their potential;
- aligning assessment with curriculum and instruction and other policies and practices;
- making inferences and/or judgments based on multiple sources of evidence; and
- viewing assessment as continual and recursive.

Research findings suggest that achievement tests of any kind are not a good predictor of success. Many forms of bias affect performance on tests: the choice of items, responses deemed appropriate, and the content selected are the product of culturally and contextually determined judgments (García and Pearson in press, Gardner 1983, and Sternberg 1985).

The factors that influence test scores (e.g., opportunities to learn, poverty and social class, test motivation and testing skills, language ability, and educational experiences outside of the classroom) are well-documented. These factors sometimes occur jointly—sometimes at different times—in the test-taking process, making it impossible to track each systematically. As Oakes et al. (1990) point out, although individual effects can be identified for both race and social class, for example, it is the combination of the two—their multiplicative power—that needs to be examined and measured. But new forms of assessment do not themselves remedy these socioeconomic complexities.

Darling-Hammond (1994b) argues that changing test forms and formats without changing the ways in which assessments are used will not change the outcomes of education. The equitable use of performance assessments depends on both the designs of the tests themselves and how well the

assessment practices are interwoven with the progress of school reform and the improvement of teaching.

However, an assessment that attempts to perform too many functions will inevitably do none well. Some functions must be passed over in favor of others, and it is at this point that the test development process can become roiled in miscommunication. It is vital to delineate appropriate roles—student diagnosis, curriculum planning, program evaluation, instructional improvement, accountability, and certification—for different assessments (Linn and Herman 1997). And importantly, whatever test is created must be credible in the eyes of the public.

In analyzing test results, their meaning must not be misunderstood. For example, the results of a test given at various grade levels should not be interpreted as if they were an assessment of the progress of the same students over time (i.e., longitudinal). The results of annual achievement data reflect a (cross-sectional) snapshot of progress at that given time. The tests administered as part of TIMSS provide rich information about the performance of U.S. students compared to those of other countries in mathematics and science, and provide connections for understanding performance within the context of curriculum and instruction at specific grade levels. However, TIMSS data are not longitudinal in nature, meaning that the same students are not being tested in the fourth grade and then, four years later, in the eighth.

Much more research is needed on the fairness and validity of new modes of assessment. In addition to these concerns, investigations into the effects of aligning assessments with rigorous standards for student achievement would benefit a multitude of local, state, and federal audiences. Nonetheless, it is not only the *form* of the tests that is important in determining the impact of an assessment program on students, teachers, and schools; it is the *use* to which the results are put (Messick 1989).

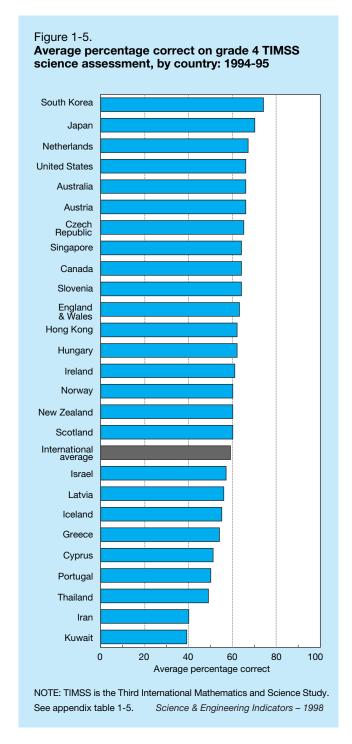
This discussion concentrates heavily on various concerns regarding the measurement of achievement at the elementary and secondary levels, where at least some actions have been taken to assess performance; this is in contrast to the postsecondary level, where gaps remain.

1-5.) In addition, U.S. fourth graders earned scores higher than the international average in all four science content areas: earth science, life science, physical science, and environmental issues/nature of science. (See appendix table 1-5.)

U.S. eighth grade students performed less well relative to other countries in science than fourth graders, scoring just above the international average. Eighth graders in the United States answered 58 percent of the science items correctly, compared with an international average of 56 percent. (See figure 1-6.) Like U.S. fourth graders, scores of U.S. eighth grade students exceeded the international average in all sci-

ence content areas: earth science, life science, physics, chemistry, and environmental issues/nature of science. (See appendix table 1-6.)

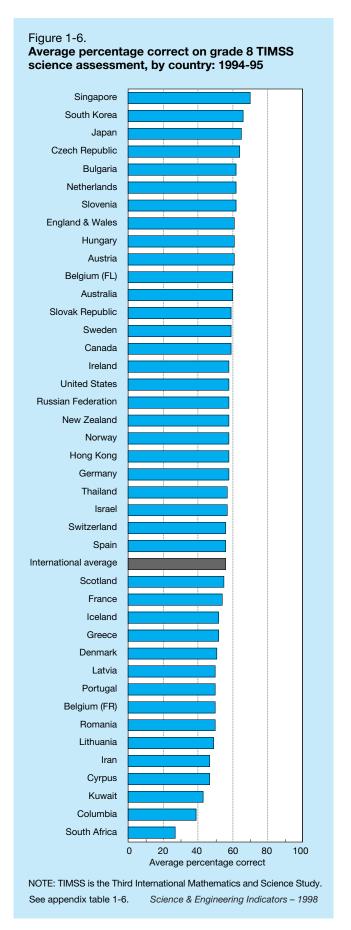
In the United States, boys scored slightly higher than girls in science at the fourth grade, but there was no difference between the sexes at the eighth grade. In other countries that participated in the study, boys outperformed girls in science in 40 percent of the countries at the fourth grade and in almost half of the countries at the eighth grade. (See appendix table 1-7.)



Mathematics Coursework

U.S. students are now much more likely to have taken advanced mathematics courses in high school than they were in years past. In 1994, close to 70 percent of seniors had completed geometry, 58 percent had completed algebra 2, and 9 percent had completed calculus.³ These figures represent a more than 20-point gain in the percentage of students taking

³Studies of high school transcripts may underestimate completion rates for algebra 1 (a prerequisite for geometry) because many college-bound students take algebra in eighth grade.



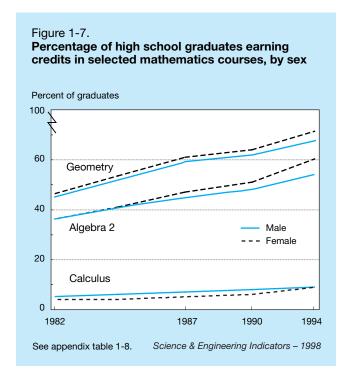
algebra 2 and geometry, and about a 5-point increase in calculus since 1982. High school females are now more likely than males to have taken geometry and algebra 2, and about as likely to have completed calculus. (See figure 1-7.)

There remain substantial disparities across racial and ethnic groups in advanced mathematics coursetaking. This gap is apparent in geometry and algebra 2 as well as in the most advanced courses in the college preparatory sequence. In calculus, about one-quarter of Asian Americans/Pacific Islanders completed the course compared with about 10 percent of whites, 6 percent of Hispanics, and 4 percent each of blacks and Native Americans.

However, despite the unequal enrollments, progress has been made in the proportion of students in all racial and ethnic groups taking advanced mathematics. Half or more of white, Hispanic, and Asian American/Pacific Islander students in the class of 1994 completed algebra 2 and geometry, the so-called gatekeeper courses for advanced study in mathematics and science. Large gains were made in groups underrepresented in mathematics between 1982 and 1994. The proportion of black students taking geometry increased from 29 to 58 percent between 1982 and 1994. The proportion of Hispanics went from 26 to 69 percent, and the fraction of Native Americans taking geometry rose from 34 to 60 percent over the period. These groups also experienced 20 to 30 percentage point gains in algebra 2. (See figure 1-8.)

Mathematics Proficiency

Mathematics performance of U.S. students remained fairly stable during the 1970s and began to improve in the 1980s. The most recent assessments indicate small but significant gains for 9-year-olds and 13-year-olds through 1996. (See



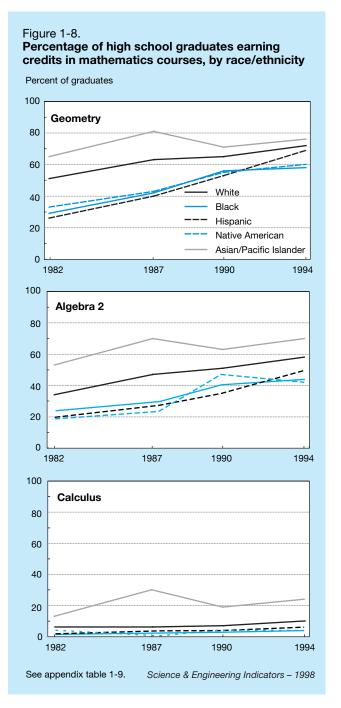


figure 1-9.) On the other hand, performance of 17-year-olds remains at the 1973 level after recovering from a slight dip in the 1980s.⁴

Although the achievement of U.S. students in mathematics has shown slight gains over time, there remains a large proportion of students unable to demonstrate anything more than basic levels of knowledge (often associated with NAEP's level 2 performance). (See "The Making of a New Mathematics Assessment.") This is particularly true at grade 12 where just one in six students performed at or above level 3 (level 4 being the highest). At grades 4 and 8, respectively, approximately one in

⁴Detailed descriptions of trends can be found in Campbell et al. (1996).

The Making of a New Mathematics Assessment

National Assessment for Educational Progress tests in 1990, 1992, and 1996 differed markedly from earlier assessments in that they were designed to reflect the relatively new content and teaching standards published by the National Council of Teachers of Mathematics (NCTM 1989 and 1991). These newer assessments included questions from the five core content areas defined by the mathematics standards:

- ◆ number sense, properties, and operations;
- measurement;
- ♦ data analysis, statistics, and probability; and
- algebra and functions.

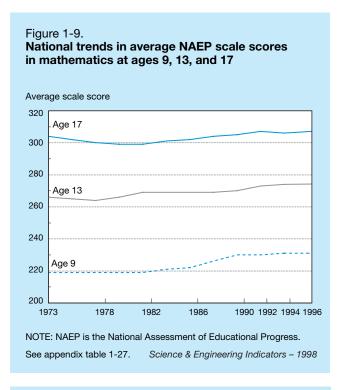
The 1990, 1992, and 1996 mathematics assessments also attempt to measure students' cognitive abilities such as those emphasized in the standards: reasoning, problem solving, and communicating with and about mathematics.

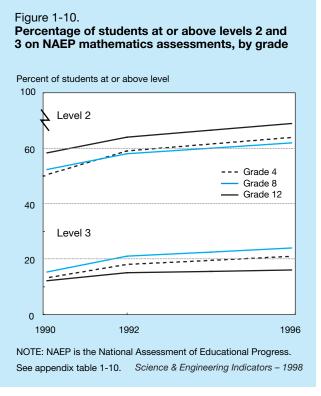
At the same time that standards-based assessments were being developed, efforts were made to associate numerical scores on the test with descriptive labels and definitions that capture the levels of knowledge and skill demonstrated by students' overall responses to test items. Results from the 1990 assessment placed performance on a continuum that ranged from knowledge of "simple arithmetic facts" at the low end to knowledge of "multistep problem solving and algebra" at the high end. Results from the 1992 and 1996 NAEPs were reported at one of four proficiency levels that ranged from "below basic" to "advanced." The value and validity of these proficiency levels have been matters of debate since their introduction (U.S. GAO 1993). To permit comparability with reported results without conveying judgments about the capabilities a particular score represents, this chapter reports performance levels simply designated as levels 1 to 4. These levels correspond numerically to the score ranges used in 1990 and 1992 mathematics assessment reports. (See appendix table 1-10.)

five and one in four students performed at this level. Despite the disappointing news, this is an improvement from 1990 when substantially fewer students demonstrated level 3 performance.

However, considerable progress has been made in the 1990s in the proportion of students performing at least at level 2. Between 62 and 69 percent—depending on grade level—of students in 1996 were able to perform the more basic levels of mathematics, compared with 52 to 58 percent in 1990. (See figure 1-10.)

In 1996, there were no substantial differences between the proportions of male and female students performing at or above





level 2 in mathematics at any grade level. A slightly higher proportion of males than females demonstrated the more advanced performance (level 3) in 4th and 12th grades, but not in 8th grade. (See appendix table 1-10.)

As in science, differences in the mathematics achievement across racial and ethnic groups have followed a consistent pattern over the years: white and Asian American/Pacific Islander students generally achieve at significantly higher levels than do black, Hispanic, and Native American students. Despite some gains between 1990 and 1996, the proportion of black, Hispanic, and Native American students who performed at level 2 or above lagged far behind that of whites and Asian/Pacific Islanders. There were about 40 points between the percentage of white students at level 2 and the percentage of black students, about a 30-point lag for Hispanics, and about 20 points for Native Americans. (See appendix table 1-10.)

Larger proportions of white students in all three grades were performing at or above levels 2 and 3 at the end of the six-year period of the assessment than they were in 1990. The percentage of black fourth graders who performed at level 2 or above increased by 13 points between 1990 and 1996. Hispanic and Native American students showed no statistically significant improvement at any grade or at any level of proficiency during that period.

Also between 1990 and 1996, there has been a striking rise in the number of states where 50 percent or more of eighth grade students scored at or above level 2 mathematics proficiency.⁵ In 1996, of the 40 states participating in the state-by-state analysis, only students in Alabama, Louisiana, Mississippi, and South Carolina failed to meet this performance criterion. In comparison, in 1992, only 23 of 35 states, and just half of 1990 participating states, could claim 50 percent or more of their students at or above level 2 performance. (See figure 1-11.) However, there were large differences among racial and ethnic groups across states in meeting the 50 percent criterion. In 1996, half or more of white eighth graders in all states achieved level 2 performance; only in Iowa, Montana, and North Dakota did half or more of Hispanic eighth grade students meet the basic level of proficiency; in no state did half or more of black students perform at this level.⁶

Studies suggest that state economic conditions play some part in mathematics achievement, although a direct and powerful relationship has not been identified. Four states in which less than half of eighth graders functioned at or above level 2 in mathematics (Alabama, Louisiana, Mississippi, and South Carolina) were compared with the six states in which three-quarters or more of students achieved at this level. Comparisons were based on three key variables: poverty rate, educational expenditure, and the percentage of minority students in each state. Comparisons suggest an association between these indicators and mathematics performance. (See text table 1-1.)

- ◆ In low-performing states, the poverty index ranged from 19 to 37 percent, and in high-performing states, from 10 to 14 percent.
- ♦ In low-performing states, average per student spending on education ranged from \$3,660 in Mississippi to \$4,761 in

- South Carolina; in high-performing states, the range was \$4,674 in North Dakota to \$6,069 in Maine.⁷
- ◆ All four of the low-performing states included much larger percentages of minority students (from 40 to 49 percent) than did high-performing states (from 9 to 17 percent).

U.S. Mathematics Proficiency in an International Context

As in science, performance in mathematics of U.S. fourth grade students in the 1995 TIMSS study was comparatively better than eighth grade performance, averaging 63 percent of items correctly answered compared with 59 percent internationally. (See figure 1-12.) But, unlike in science, U.S. mathematics performance at fourth grade was far behind that of Singapore, South Korea, Japan, and Hong Kong—whose fourth grade students averaged 73 to 76 percent correct—and a host of other countries. (See figure 1-13.) U.S. eighth graders answered just over half of the items on the mathematics assessment correctly. This was below the international average of 55 percent correct, and students in the highest performing nations—Singapore, South Korea, Japan, Hong Kong, and Flemish-speaking Belgiumaveraged 65 percent correct or higher. In most countries—including the United States—there were no differences between the sexes in mathematics performance at the fourth or eighth grade. (See "Mathematics and Science Achievement of the Highest Performers" and appendix table 1-14.)

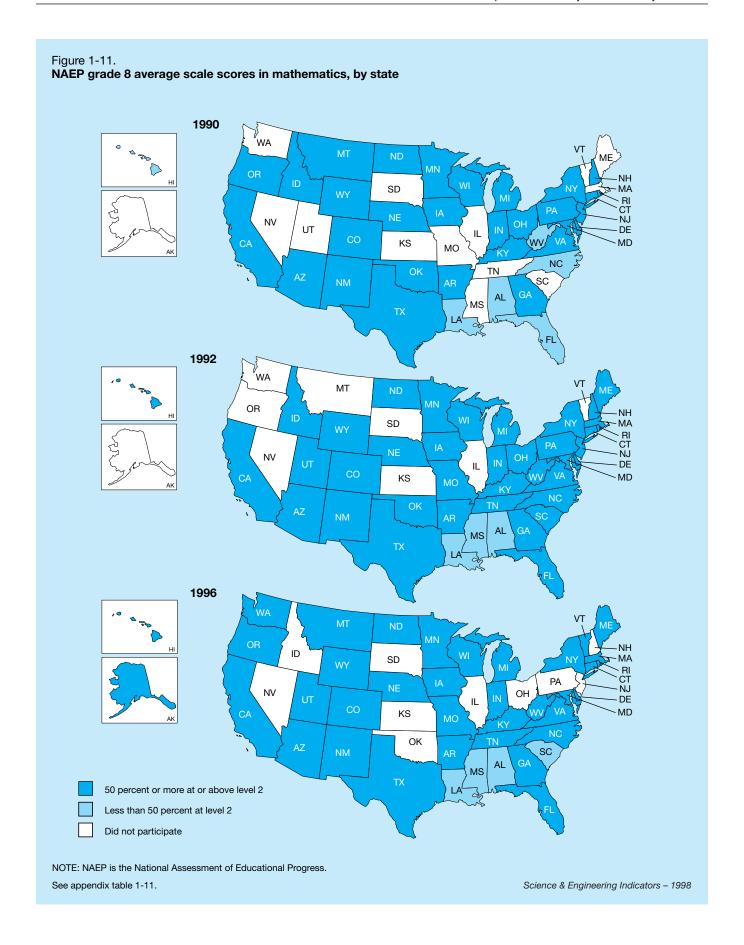
Mathematics and Science Achievement of the Highest Performers

Achievement can also be evaluated by comparing the top students in different nations. Often, the comparison is based on the proportion of each nation's students scoring in the top 10 percent of the international distribution. As would be expected on the basis of findings already presented, proportionately more students from Singapore, South Korea, and Japan came out on top in both subjects and at both the fourth and eighth grade levels. For example, at the eighth grade level, 45 percent of the students from Singapore scored in the top 10 percent of the international mathematics distribution and 31 percent scored at the top of the science distribution. A smaller percentage of U.S. students made the top cut. In science, 13 percent of eighth grade students and 16 percent of fourth grade students scored in the top 10 percent of their respective international distributions. In mathematics, only 5 percent of U.S. students in eighth grade and 9 percent of students in fourth grade reached the top 10 percent international benchmark. (See appendix table 1-15.)

⁵Because only eighth grade students participated in all three of these assessments, only their performance is considered in these comparisons.

⁶Because sample sizes for Native American and Asian/Pacific Islander students were too small in most states to provide reliable estimates of proficiency levels, these comparisons are not made here but can be found in appendix table 1-11.

⁷These figures are not adjusted for differences in cost of living among states.



Text table 1-1.

Selected characteristics of low- and high-performing states on the mathematics National Assessment of Educational Progress: 1996

State	Percentage of students at or above level 2	Percentage of 5- to 17-year-olds in poverty	Per pupil educational expenditures (\$)	Percentage of minority students
National total	61	20.1	5,767	31
Low-performing states				
Alabama	45	19.5	4,037	40
Louisiana	38	36.8	4,519	45
Mississippi	36	28.2	3,660	51
South Carolina	48	18.7	4,761	49
High-performing states				
lowa	78	13.5	5,288	9
Maine	77	9.6	6,069	7
Minnesota	75	13.7	5,720	14
Montana	75	12.3	5,598	17
Nebraska	76	12.5	5,651	15
North Dakota	77	11.6	4,674	9

SOURCES: C. O'Sullivan, C. Reese, and J. Mazzeo, *NAEP 1996 Science Report Card for the Nation and the States* (Washington, DC: National Center for Education Statistics, 1997); C. Reese, K. Miller, J. Mazzeo, and J. Dossey, *NAEP 1996 Mathematics Report Card for the Nation and the States* (Washington, DC: National Center for Education Statistics, 1997); and National Center for Education Statistics, *Digest of Educational Statistics* 1996, NCES 96-133, (Washington, DC: U.S. Government Printing Office, 1996), table 165.

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The performance of students varied over mathematics content areas both within and among countries. In fourth grade mathematics, U.S. students performed at or above the international average in all areas except measurement. (See appendix table 1-12.) U.S. eighth grade students performed best on algebra, fractions, and data representation/analysis, where performance was on a par with international averages. They did less well on proportionality, geometry, and measurement. (See appendix table 1-13.)

Curriculum and Instruction

When student assessments reveal differences in performance across nations or states or within population groups of the magnitude that they have displayed in the assessments analyzed here, there is a compelling policy need to explore the sources of these disparities. A better understanding of why some groups of students perform well in mathematics and science while others do not can help educators and policymakers in deciding which facets of the education system require more or less attention.

Many recent analyses have focused on differences in the educational experiences of students. The Third International Mathematics and Science Study provides more comprehensive information on the educational experiences of students than any international (and many national) studies conducted to date. Within this large-scale study, a curriculum analysis provides country profiles of the mathematics and science that students are ex-

pected to learn at each grade. Student and teacher surveys provide information on the subject matter content and activities that make up a lesson; and a video study (for the United States, Germany, and Japan) provides observational information on what actually takes place in a sample of eighth grade mathematics classrooms.

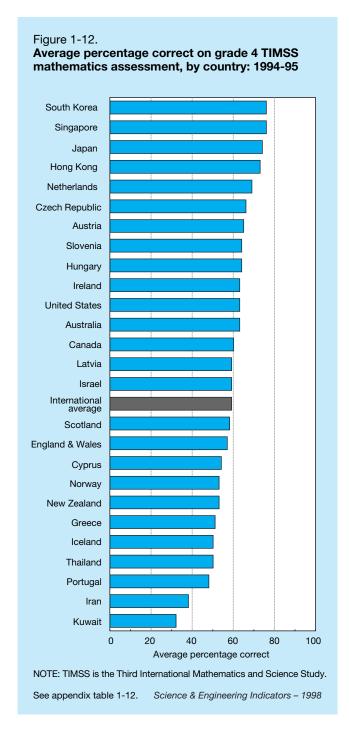
Mathematics Curricula

In most countries, curricula focus on a limited number of topics at each grade. Each topic is introduced in the grade sequence and continues until a point when it is discontinued in favor of a new topic. In contrast, U.S. curricula follow a spiral approach: a topic is introduced in its simplest terms in early grades and continues in more advanced forms into later grades. Topics thus "spiral" throughout the curriculum—in theory, providing greater depth, elaboration, and complexity at each appearance. Three central ideas underlie the U.S. approach. First, content is more easily mastered when broken into "bite-sized" pieces. Second, the pieces are best learned when presented in order of difficulty and complexity. Third, students must master each piece before moving on to the next.

However, this approach when put into actual practice has important consequences for learning and instruction that are not always consistent with the theory. The U.S. curricula include a great deal of repetition over grades, and despite the intent to present new aspects of a topic at each appearance,

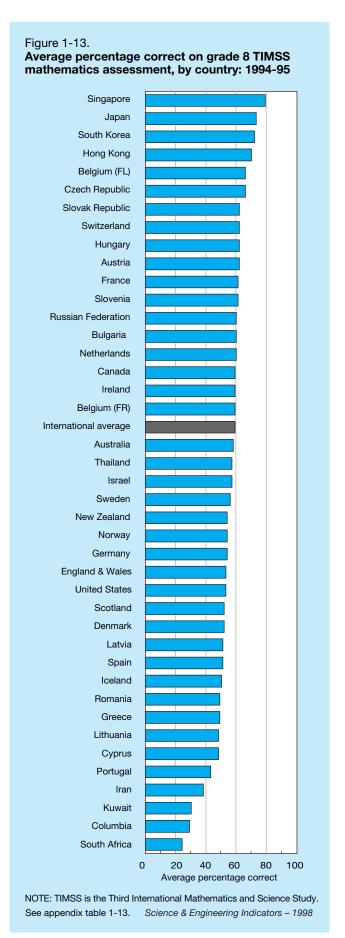
⁸Items and topics in the assessment were grade-specific. For example, the fourth grade test focused on whole numbers with a limited number of questions on fractions. The eighth grade test focused on rational numbers (fractions and decimals)

⁹Details of the curriculum study's methodology and findings are presented in Schmidt, McKnight, and Raizen (1997) and in two companion volumes (Schmidt, McKnight et al. 1997 and Schmidt, Raizen et al. 1997)—one for science and one for mathematics—written by these and other members of the TIMSS research team.



much of the information seems to get rehashed from previous levels. On average, topics remain in the mathematics curriculum as a whole two years longer than is the norm internationally. And the curriculum includes a large number of topics since few are dropped as others are added. On average, the U.S. mathematics curriculum covers more topics than are covered in 75 percent of countries that participated in the 1995 international study.

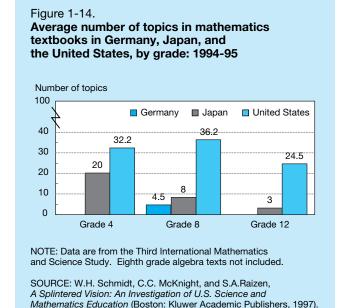
Analyses of topics covered at various grade levels in mathematics textbooks across the world illustrate this point. At fourth grade, the five most emphasized math-



ematics topics accounted for 60 percent of page space in U.S. textbooks but over 85 percent internationally. In eighth grade mathematics, the five most emphasized topics in U.S. (nonalgebra) texts accounted for less than 50 percent of total coverage, compared with 75 percent internationally. U.S. eighth grade textbooks for regular, nonalgebraic mathematics cover approximately 36 different topics, compared with an average of 8 topics in Japanese and 4.5 topics in German texts. It Findings are similar for the 4th and 12th grades. (See figure 1-14.)

A review of the topics emphasized at each grade level reveals that U.S. mathematics texts are also often out of step with the international norm. For example, at eighth grade—where U.S. students perform relatively poorly in mathematics compared with other nations—the international norm is to focus on algebra and geometry. In the United States, eighth grade texts place greater emphasis on whole numbers, decimals, and fractions—topics that most other countries have already completed. Videotaped lessons confirm this finding. Lessons in German and Japanese classrooms were focused on algebra and geometry, while, in about 40 percent of the cases, U.S. lessons focused on arithmetic (NCES 1996c).¹²

¹²Key findings from the video summary are presented in NCES (1996c). Details of the methodology, coding schemes, and findings have been presented in a recently issued volume prepared by James Stigler and colleagues at UCLA (Stigler et al. 1997).



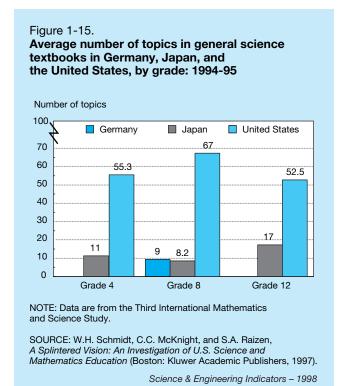
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Science Curricula

Overall, the U.S. science curriculum has more in common with the curricula of other countries than is the case for U.S. mathematics. Still, U.S. science curricula reflect some of the patterns observed in mathematics. In the United States, new topics are introduced at regular intervals in the first five grades. Much of the content seems repetitive until about 10th grade, when general science is replaced by courses devoted to specific areas of science such as biology, chemistry, or physics.

However, in the elementary and middle grades, U.S. students take general science courses that cover more topics than are covered in most of the participating countries. General science textbooks in the United States tend toward inclusiveness, covering more distinct topics than are covered in texts in 75 percent of the other countries. The typical U.S. science textbook covers between 53 and 67 topics, depending on grade level. In Japan, the range is 8 to 17 topics. In Germany, where data were available only for eighth grade, the average is nine topics. (See figure 1-15.)

This tendency toward inclusive coverage means that most general science textbooks in the United States touch on topics rather than concentrating on them. As an example, the five most emphasized topics in U.S. fourth grade science texts accounted for 25 percent of the total textbook space, compared with an international average of 70 to 75 percent. In eighth grade, the five most emphasized topics in U.S. general science texts accounted for 50 percent of textbook space, compared with 60 percent internationally.



¹⁰The five most emphasized topics in eighth grade algebra texts in the United States accounted for 100 percent of textbook space.

¹¹Results of the curriculum analysis for German texts are reported only for eighth grade.

Instructional Practice and Quality

Textbooks and curriculum guides are not the only critical factors in curriculum and instruction. Equally critical from the perspective of educational reformers are instructional considerations such as the amount of time students spend engaged with subject matter, the kinds of tasks used to facilitate their problem-solving and thinking capacities, and the technological tools available to support active student learning.

Differences in student performance outcomes are determined, at least to some degree, by differences in instructional practice and instructional quality. Science instruction in the United States may be roughly comparable to science instruction in other countries. But, as revealed in the recent international comparison, eighth grade mathematics classes in the United States are pitched at a lower level than in higher achieving countries. While U.S. eighth graders are still working on "high-end arithmetic," their peers in other countries are learning algebra and geometry.

The international comparison also revealed differences in goals, activities, and overall lesson quality in the United States, Germany, and Japan. The goal of mathematics lessons in the United States and Germany was most often to have students learn a particular skill, while the goal in Japanese classrooms was more often to help students develop deep understandings of mathematics (see NCES 1997c). These differences in goals translated into differences in other aspects of instruction. For example, 71 percent of Japanese teachers provide learning activities that require high-level thinking and reasoning. In comparison, only 29 percent of German teachers and 24 percent of U.S. teachers engaged students in this kind of learning (NCES 1997c).

On the basis of a videotaped sample of eighth grade mathematics classrooms in the three countries, judges rated most lessons from U.S. classrooms to be of low quality (87 percent), compared with 40 percent of lessons from German classrooms and just 13 percent of Japanese lessons. These judgments were made independently of detailed summaries that documented the exact sequence of mathematical statements and equations presented and the learning activities used. Any words that provided clues to the identity of the country were disguised.

None of the lessons from U.S. mathematics classrooms were rated high on quality, compared with 30 percent of lessons from Japanese classrooms and 23 percent from German classrooms. Moreover, most of the expert judges viewed lessons in Japanese classrooms as more consistent with U.S. mathematics standards than lessons in U.S. classrooms. However, 75 percent of the U.S. teachers of those same lessons judged their own instruction to be in "some accord" with the standards.

Time on Learning

Aside from the issue of instructional quality, there has been some empirical evidence to support the common-sense notion that the more time students spend engaged in learning, the more they will learn. This is the primary reason why time is considered an important instructional variable. It is considered so crucial, in fact, that many educators believe systemic change cannot be successful in schools unless ways are found to provide students with more learning time (National Education Commission on Time and Learning 1994). Still, questions remain about just how much influence instructional time has on achievement.

Through the recent international comparative study, it has become clear that, at the very least, the relationship is not as simple as has been assumed. In fact, no consistent relationship was observed between class time and achievement in either subject at either fourth or eighth grade. 13 This finding suggests that how teachers and students spend their instructional time is more important than the amount of time available for mathematics and science instruction during the school day. For example, eighth grade students in Belgium, the Czech Republic, and the Slovak Republic—all high-performing nations—reported spending more time than the average on mathematics. But so too did students in Kuwait, who were among the lowest scorers. South Korean and Japanese eighth graders reported spending the international average amount of class time on mathematics but were among the highest achievers.

U.S. students spend at least as much class time on mathematics and science as students in most countries. At eighth grade, over half of U.S. students spend 3¹/₂ to 5 classroom hours on mathematics each week compared with an international norm of 2 to 3¹/₂ hours (Beaton, Mullis et al. 1996; and Beaton, Martin et al. 1996). ¹⁴ Almost half of fourth grade U.S. students spend five or more hours of instructional time each week on mathematics and three hours or more on science. In most other countries, fourth graders spend about three to four hours on mathematics and two hours on science (see Martin et al. 1997 and Mullis et al. 1997). ¹⁵

Although learning time can be extended through homework and study before or after the school day, no consistent relationship has been found between international achievement and the amount of time students reported spending on homework. In some high-achieving countries such as Hungary, Singapore, and Slovenia, students spend considerably more time than the norm on homework. However, students in low-achieving countries such as Iran and Kuwait also reported considerable time on homework. In Denmark, Scotland, and the Netherlands—which are middle- to high-achieving countries—one-quarter to one-half of the students reported spending no time at all on homework on a normal day.¹⁶

Students in most countries reported spending an hour of nonschool time on mathematics on a normal day and a half-

¹³See table 4.9 in each of the following sources: Beaton, Mullis et al. 1996; Beaton, Martin et al. 1996; Martin et al. 1997; and Mullis et al. 1997.

¹⁴See Beaton, Mullis et al. (1996, table 5.5). Comparable figures are not available for eighth grade science classes in the United States.

¹⁵For mathematics, see Mullis et al. (1997, table 5.4); for science, see Martin et al. (1997, table 5.5).

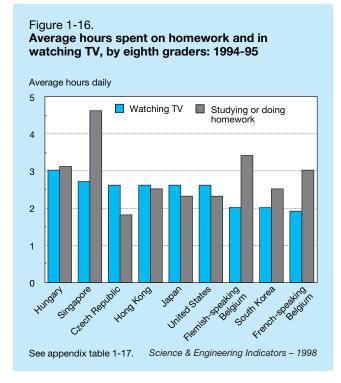
¹⁶See table 4.9 of Beaton, Mullis et al. (1996); and Beaton, Martin et al. (1996).

hour to an hour on science. U.S. students averaged 48 minutes to one hour on mathematics homework and between 36 and 48 minutes on science, depending on grade level (Beaton, Mullis et al. 1996; Beaton, Martin et al. 1996; Martin et al. 1996; and Mullis et al. 1996). (See appendix table 1-17.)

Homework competes with extracurricular activities for students' attention, and television often turns out to be the prime competitor. In most countries, eighth grade students spend two to three hours a day watching television. (See figure 1-16) The habit of U.S. students are consistent with these patterns: eighth graders reported spending 2.6 hours watching television, compared with 2.3 hours doing their school homework or studying. Not only was this within the international norm, but it was virtually identical to patterns exhibited by Japan and Hong Kong, two of the top-scoring economies. Students in other high-scoring countries such as Singapore and Belgium spent somewhat more time studying than watching television; however, students in the Czech Republic spent more time watching television than studying.

The relationship of achievement to time spent viewing television is more consistent than the relationship between achievement and time spent on homework—but it turns out to be a curvilinear relationship. Students who watched one to two hours of television were the highest achievers in most countries. Students who watched more than two hours of television or less than one hour had lower mathematics and science achievement on average. More significant perhaps was the finding that eighth grade students who watched televi-

¹⁷Beaton, Mullis et al. (1996, table 4.6). Also see table 4.9 of Beaton, Mullis et al. (1996); Beaton, Martin et al. (1996); Martin et al. (1997); and Mullis et al. (1997) for frequency if distribution of homework/study time.



sion for five or more hours each day, and fourth grade students who watched TV for four or more hours, were the lowest achievers in all participating countries. The United States had a fair number of students who spent this much time watching television—17 percent of fourth grade students and 13 percent of eighth grade students (Beaton, Mullis et al. 1996; Beaton, Martin et al. 1996; Martin et al. 1997).

Use of Instructional Technologies

Educational standards in both mathematics and science acknowledge the potential benefits of technology and recommend that students have regular access to computers and other tools such as calculators. Although there are studies of individual schools or districts where the use of computers and access to the Internet have yielded learning gains, there are no national data that affirm that the presence of technology in itself is spurring achievement gains in mathematics and science nationwide. It is probably often the case that information technologies, when available, are not being used effectively in the classroom; nor does it seem from empirical analysis that educators have yet understood how to integrate technology into programs of reform on a wide scale.

By 1994, more than half of U.S. middle and high school students reported access to computers in school for mathematics instruction; of that number, about 62 to 70 percent actually used the computers to solve mathematics problems. This represents a large increase from 1978 when only 56 percent of 13-year-olds and 46 percent of 17-year-olds used computers for problem solving during instruction. (See text table 1-2.)

Teacher responses from recent international comparisons paint a slightly more limited picture of computer use for mathematics

Text table 1-2.

Percentage of students reporting school access to computers for mathematics instruction and learning

		13-year-olds reporting	17-year-olds reporting
Computer access/use	Year	yes	yes
Had access to			
computer to learn	1978	12	24
	1994	48	52*
Studied through			
computer instruction	1978	14	12
	1994	50*	34*
Used a computer to			
solve problems	1978	56	46
·	1994	70*	62*

^{* =} statistically significant difference between the two years, at a 5 percent combined significance level per set of comparisons

SOURCE: J. Campbell, C. Reese, C. O'Sullivan, and J. Dossey, *NAEP 1994: Trends in Academic Progress* (Washington, DC: National Center for Education Statistics, 1996).

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instruction. When asked about the use of computers in mathematics instruction, three-quarters of U.S. teachers at the eighth grade level reported that students never or hardly ever solve mathematics problems using a computer. Sixty percent of U.S. fourth grade teachers reported that students never or hardly ever use the computers in solving mathematics problems. However, mathematics teachers reported frequent instructional use of calculators. More than half of eighth grade mathematics teachers in the United States reported that students in their classes use calculators for basic tasks such as checking answers and performing routine computations. More than half also reported having their students use calculators to solve complex problems and more than one-third to explore number concepts (Williams et al. 1997). (See appendix table 1-23.)

Across the world, computers are used quite rarely for mathematics and science instruction. Except in Denmark, England and Wales, and Slovenia, less than one-fifth of eighth grade students used computers for problem solving in science. And except in the United States, Austria, Denmark, England and Wales, and Sweden, less than one-third of fourth grade students used computers at least some of the time according to teachers' reports. (See appendix table 1-16.)

Limited availability of computers at school can be offset by access to computers at home, even though home computers are often used for other than academic purposes. During the 1994/95 school year, about half of U.S. students had a computer at home. Students in England and Wales, Iceland, Ireland, the Netherlands, and Scotland were most likely to own computers (about 75 percent); students in Colombia, Iran, Latvia, Romania, and Thailand were least likely (less than 20 percent). (See text table 1-3.)

The vision of tomorrow's classroom held by many educational reformers not only includes access to computers by students and teachers but also widespread access to the Internet. Although most U.S. schools are quite far from this vision, Internet access in schools has increased substantially in the last several years. A recent survey indicated that in fall 1996, 65 percent of public schools reported access to the Internet—a gain of 30 percentage points over 1994 figures. Internet access was more likely in secondary than in elementary schools (three-quarters versus under two-thirds); in more affluent than less affluent schools (78 percent versus 53 to 58 percent); and in schools with low to moderate minority enrollments, as compared with schools with high minority enrollments (65 to 72 percent versus 56 percent). (See appendix table 1-25.) As with computers, access to the Internet does not always translate into use by students and teachers, nor does it ensure effective use. Although close to two-thirds of U.S. schools could connect to the Internet, access was pos-

Text table 1-3.

Percentage of students reporting that they have a computer at home, by country: 1994-95

Country	Grade 4	Grade 8	Country	Grade 4	Grade 8
Australia	63	73	Kuwait	66	53
Austria	61	59	Latvia	21	13
Belgium (Flemish-speaking)	-	67	Lithuania	_	42
Belgium (French-speaking)	_	60	Netherlands	80	85
Canada	52	61	New Zealand	53	60
Colombia	_	11	Norway	56	64
Cyprus	35	39	Portugal	34	39
Czech Republic	33	36	Romania	_	19
Denmark	_	76	Russia	-	35
England and Wales	88	89	Scotland	89	90
-rance	_	50	Singapore	44	49
Germany	_	71	Slovak Republic	_	31
Greece	23	29	Slovenia	43	47
Hong Kong	37	39	South Korea	23	39
Hungary	37	37	Spain	_	42
celand	81	77	Sweden	_	60
ran	8	4	Switzerland	_	66
reland	79	78	Thailand	3	4
Israel	70	76	United States	56	59

^{- =} did not participate in fourth grade assessment

SOURCES: A. Beaton, I. Mullis, M. Martin, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1996); and I. Mullis, M. Martin, A. Beaton, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1997).

¹⁸U.S. data on computer use are reported only for mathematics classes. Fourth grade teachers were not asked about computer use in science. The response rate for eighth grade science teachers in the United States was too low for estimates to be reliable.

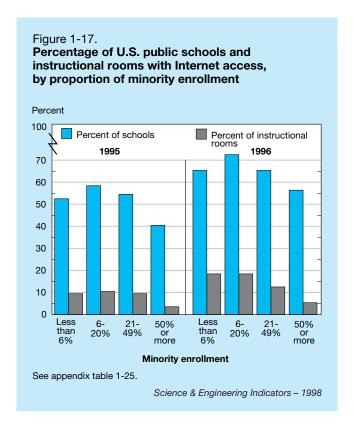
sible from only 14 percent of instructional rooms (e.g., class-rooms, computer labs, library media centers) according to recent surveys (NCES 1997a). (See figure 1-17.)

Teachers and the Profession of Teaching

The National Council of Teachers of Mathematics' standards and the National Research Council's science standards present new visions of what should be taught, as well as when and how it should be taught. Standards in both subjects call for teachers to introduce and develop topics that, in the past, were reserved for later grades and to orchestrate instruction in ways that are not commonly observed in today's classrooms. At present, few teachers possess both the knowledge of teaching and learning and the knowledge of content necessary to meet these expectations for the effective teaching of mathematics and science.

Teacher Preparation and Student Achievement

Until recently, attempts to link student achievement to teacher qualifications focused on degrees earned and major or minor fields of study. These attempts have not been altogether successful; few, if any, consistent effects were found. This was a sensible research strategy at the time because teacher certification requirements were specified in those terms. But more contemporary findings suggest that additional coursework in specific areas may not only increase teachers'



knowledge of subject matter, but may also expand the range of teaching and learning approaches a teacher is likely to use in the classroom—and expand student achievement.

Recent studies are using more refined ways to measure teacher qualifications and, as a result, have established that the number and kind of courses taken by mathematics and science teachers do influence student performance. Higher student test scores have been related to teachers who have had more advanced courses in mathematics and science and in other educational areas. Taking additional coursework in unrelated subjects had no—or sometimes even a negative—effect on student learning (Monk 1994).

In addition, students whose teachers have completed more course credits in their field (and those with higher grade point averages) achieve at higher levels than other students. In a study conducted by Chaney (1995), teachers who had taken courses in mathematics at above calculus level coupled with courses in mathematics education were found to have students who less frequently scored in the lower achievement grouping and more often demonstrated advanced levels of performance. (See appendix table 1-26.) In addition, these better prepared teachers were more likely to expose their lower level mathematics students to college preparatory subjects such as algebra in regular mathematics classes (Chaney 1995).

Still other studies examining the knowledge base and preparation of teachers have identified important differences in instruction. Several of these studies showed that when covering topics on which they were well-prepared, teachers more often encouraged student questions and discussion; spent less time on unrelated topics; permitted discussion to move in new directions on the basis of student interests; and generally presented the topics in a more coherent, organized fashion. When covering unfamiliar topics, teachers discouraged active participation by students, kept discussion under tight rein, relied more on presentations than on student discourse, and spent more time on tangential issues such as study skills and cooperative effort (see, e.g., Carlsen 1991, and Smith and Neale 1991).

Coursework Preparation

An increasing number of states are requiring that teachers have a college major or a minimum number of credits in the subjects they plan to teach. Twenty-nine states now require, at least at the middle and high school levels, that teachers have a degree in a specific subject area other than education. Nine of these states also require this of elementary school teachers (CCSSO 1996). (See appendix table 1-20.)

As of the 1993/94 school year, 1 percent of elementary school teachers possessed a mathematics degree, 2 percent had a science degree, and only 5 or 6 percent more had either majored or minored in mathematics or science education in college. The vast majority of elementary school teachers earn college degrees in education rather than in specific disciplines or disciplinary areas of education. High school teachers were much more likely to possess mathematics and science degrees. Of high school mathematics teachers, 41 percent had

earned a degree in mathematics compared with just 7 percent of middle school teachers. In science, 63 percent of high school, and 17 percent of middle school, science teachers possessed some form of science degree. (See text table 1-4.)

The professional associations have made specific recommendations for the preparation of mathematics and science teachers. (See "Are Teachers Knowledgeable About the Standards?") The NCTM standards recommend that middle school mathematics teachers take college courses in abstract algebra, geometry, calculus, probability and statistics, and applications of mathematics/problem solving. An even more detailed list of coursework is recommended for high school mathematics teachers (Weiss, Matti, and Smith 1994).

Many middle school mathematics teachers fall short of these recommendations. Only 7 percent of middle school mathematics teachers have taken courses in all of the areas recommended by the standards, and about one-third have taken none. High school teachers are generally better prepared. About one-third have completed courses in at least 9 of 10 recommended areas, and only 2 percent have completed just one course or none of the recommended coursework. Virtually all elementary school teachers have completed some courses in mathematics education or mathematics for elementary teachers: 42 percent have completed college algebra/trigonometry, or elementary functions, but only 12 percent have completed calculus (Weiss, Matti, and Smith 1994).

The National Science Teachers Association recommends that elementary school teachers have one course each in the biological, physical, and earth sciences as well as coursework in science education. Just about half of elementary teachers have satisfied this requirement. Middle school science teachers are encouraged to take at least two courses in each area as well as teacher training in their field (Weiss, Matti, and Smith 1994). Only 42 percent of middle school science teachers (grades 5 to 8) and 57 percent of junior high school (grades 7 to 9) science teachers meet the Association's recommendations in full. Recommended courses for the prospective high

school teacher are quite detailed in each of the three areas of science, and there is a considerable range in the number of teachers meeting those recommendations. Less than half of earth science teachers, compared with 90 percent of biology teachers, had taken six or more credits in their respective subject areas (Weiss, Matti, and Smith 1994).

Teachers' Views of Teaching and Learning

How teachers go about their work in classrooms depends to some extent on their views about the nature of their academic disciplines and about teaching and learning in their fields. Research in the last 10 years supports this claim (Dwyer 1993a and 1993b). Teachers who see science as a static collection of facts tend toward instructional approaches that rely on "teachertalk" and direction, and on student practice and memorization. Teachers who see science as a process of empirical discovery are more comfortable with hands-on learning and open-ended tasks (Carlsen 1991, and Smith and Neale 1991). Others have made similar observations about the views and practices of mathematics teachers (Dossey 1992 and Thompson 1992).

The majority of teachers have fairly practical views of mathematics and science. Close to 80 percent of teachers in both subjects see their fields as providing "formal ways of representing the real world," and close to 90 percent as a "structured guide for addressing real situations." Only 31 percent of mathematics teachers and 18 percent of science teachers view their subject as an abstract conceptual system.

A number of teachers have views that run counter to the general directions set by standards. Close to 80 percent of mathematics teachers believe that some students have a natural talent for mathematics while others do not, and 35 percent think that mathematics should be learned as a set of algorithms or rules. In science, teachers sometimes hold similar views. Almost two-thirds of science teachers believe that some students have a natural talent for science and others do not. About three-quarters believe that students should be given prescriptive and sequential directions for doing experiments;

Text table 1-4.

Percentage of teachers with majors and minors in science/mathematics and science/mathematics education: 1993

Major/minor	Science teachers			Mathematics teachers		
	Grades 1-4	Grades 5-8	Grades 9-12	Grades 1-4	Grades 5-8	Grades 9-12
Undergraduate major in science/mathematics Undergraduate or graduate major in science/science	2	17	63	1	7	41
education or mathematics/mathematics education Undergraduate or graduate major or minor in science/science education or mathematics/	3	21	72	1	11	63
mathematics education	7	32	94	7	18	81

SOURCE: I.R. Weiss, M.C. Matti, and P.S. Smith, Report of the 1993 National Survey of Science and Mathematics Education (Chapel Hill, NC: Horizon Research, Inc., 1994).

Are Teachers Knowledgeable About the Standards?

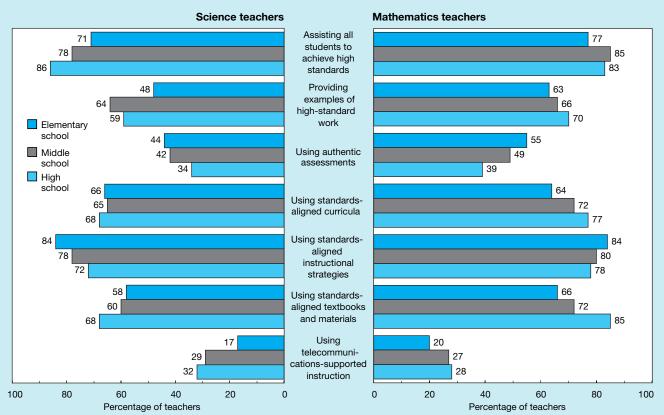
In a 1995 survey of teachers, 85 percent of eighth grade mathematics teachers reported being "fairly" or "very" familiar with the *Curriculum and Evaluation Standards for School Mathematics* of the National Council of Teachers of Mathematics. Approximately 26 percent of eighth grade science teachers reported being "very" or "fairly" familiar with *Benchmarks for Science Literacy* of the American Association for the Advancement of Science. The numbers might have been higher if teachers had been asked about standards published by the National Science Teachers Association, an organization to which many science teachers belong (Williams et al. 1997). However, it should be noted that neither of these sets of science standards realized the same levels of visibility and acceptance by the science teaching commu-

nity as was true of the mathematics standards within the mathematics teaching community.

There are indications that U.S. teachers believe they are implementing some aspects of standards-based instruction. A 1996 survey asked teachers to report on the kind of reform activities they are implementing in their classrooms. The seven-item list of activities included assisting students to reach high standards, using curriculum materials aligned with standards, and using authentic assessments. (See figure 1-18.) Except for using authentic assessments and telecommunications to support instruction, in the majority of cases, mathematics and science teachers at all three levels of schooling believed they were implementing each of the activities included in the survey (NCES 1997d).

Figure 1-18.

Percentage of science and mathematics teachers implementing reform activities in their classes: 1996



SOURCE: National Center for Education Statistics, Status of Education Reform in Public Elementary and Secondary Schools: Teachers' Perspectives (Washington, DC: U.S. Department of Education, 1997), forthcoming.

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only 32 percent thought focusing on rules might be a bad idea. (See figure 1-19.)

There is substantial agreement between mathematics and science teachers on the aptitudes and skills students need to succeed in learning mathematics and science. Over 80 percent of mathematics and science teachers consider it very important for students to understand concepts, to understand how the subjects are used in the real world, and to be able to support their results and conclusions.

There are some areas of difference in these views. Fewer mathematics teachers (65 percent) than science teachers (73 percent) consider creative thinking very important. However, the biggest difference in views centers on the importance of students remembering formulas and procedures. Over 40 percent of mathematics teachers believe that it is important for students to memorize formulas, compared with 26 percent of science teachers. (See figure 1-20.)

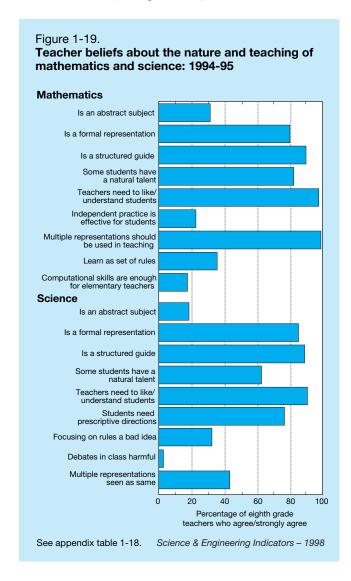


Figure 1-20. Teacher perceptions of student skills required for success in mathematics and science: 1994-95 Percent of eighth grade teachers responding "very important" 100 90 science 80 70 60 50 40 30 20 10 sequental right free stand Jes in tel month Understand concepts Think deathery 0 Selected student skills See appendix table 1-19. Science & Engineering Indicators - 1998

Out-of-Field Teaching

Information about the academic preparation of the teaching force and their views and attitudes toward teaching and learning do not tell the complete story of teachers' qualifications. All too frequently, teachers are assigned to classes outside their fields (Ingersoll 1996). The problem is particularly acute in mathematics. In the 1990/91 school year, students were less likely to have a qualified teacher in mathematics than in any other core subject. About 27 percent of students in grades 7 to 12 had a mathematics teacher without at least a minor in mathematics or mathematics education compared with 21 percent in English, 17 percent in science, and 13 percent in social studies. Out-of-field teaching is more common at middle and junior high schools than in senior high schools. In 1991, 32 percent of students in 7th grade science classes had teachers without a major or minor in science or science education, while only 13 percent of 12th graders did. (See appendix table 1-24.)

There are large differences across states in the proportions of mathematics and science teachers who have degrees in these subjects. The percentage of secondary mathematics teachers with a major in mathematics ranges from under 45 percent in Alaska, Delaware, and Washington to over 80 percent in Pennsylvania and the District of Columbia. Similarly, fewer than half of sec-

ondary science teachers in Nevada and Louisiana majored in science in college compared with 80 or more percent in 10 states (Blank and Gruebel 1995).

There are also equity issues involved with out-of-field teaching which is more prevalent in high-poverty schools, in lowachieving classes, and in low-track classes (Chaney 1995; Gamoran 1986; and Oakes, Gamoran, and Page 1992). For example, more than one-quarter of students enrolled in secondary school science classes in which students were judged to be low achieving had a teacher without at least a minor in science or science education, compared with fewer than 1 in 10 students in high-achieving classes. Thirty-six percent of students in classes with high minority enrollments had a mathematics teacher without a major or minor in mathematics or mathematics education, compared with 23 percent of students in low minority classes. In addition, students who attend school in high-poverty areas are much more likely to have mathematics and science teachers without at least a minor in these fields than students attending schools in low-poverty areas. (See figure 1-21.) In effect, students who need the most support are left with the teachers least qualified to help them (Darling-Hammond 1994a; Oakes 1990; and Weiss, Matti, and Smith 1994).

Reform of the Teaching Profession

Many efforts in the last decade to bring about systemic, standards-based changes in schools have focused on the professionalization of teaching. The logic underlying this approach is that upgrading the profession will increase teachers' commitment and motivation. This will in turn result, it is believed, in better teaching, with the final outcome being improved student learning. A variety of proposals have been offered for improving the status and professional credentialing of teachers. The most ambitious of these proposals seek changes in how teachers are prepared, licensed, and supported throughout their careers (see, for example, Carnegie Forum on Education and the Economy 1986, and National Commission on Teaching and America's Future 1996).

The National Commission on Teaching and America's Future, for example, recommends:

- organizing teacher education and professional development programs around the standards;
- developing extended graduate level teaching programs that offer year-long internships, similar to those offered in the medical profession, to provide closely supervised practice that is tied to coursework; and
- creating stable, high-quality professional development services to support teachers.

Efforts are under way to bring about each of these changes. Some of these initiatives have focused primarily on teacher preparation. The Holmes Group, which was formed by college deans of education, proposed that prospective teachers be required to devote four years of undergraduate study to academic content in their chosen major, and that professional preparation in teaching be postponed to a fifth or sixth year

Figure 1-21. Percentage of public secondary students taught by teachers without at least a minor in the field, by school poverty enrollment: 1993-94 Percent of students Low-poverty school ■ High-poverty school 70 60 50 40 30 20 13 10 0 English Social Mathe-Science Biology Chemistry Physics NOTE: In a low-poverty school, 0 to 5 percent of students are eligible for free or reduced-price lunch; in a high-poverty school, 41 to 100 percent of students are eligible for free or reduced-price lunch. The percentages for biology, chemistry, and physics represent students taught by teachers without at least a minor in those particular fields SOURCE: National Center for Education Statistics, *The Condition of Education 1996*, NCES 96-304 (Washington, DC: U.S. Department of

(Holmes Group 1986). Year-long internships, two-year induction periods, and professional development schools are all variations on this basic idea aimed at providing prospective teachers with both better academic preparation and more classroom experience before licensing.

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Education, 1996)

Other efforts have focused on development of standards to guide the profession. The National Board for Professional Teaching Standards has developed standards for accomplished teaching, created performance-based certification exams to identify accomplished teachers, and established a professional board to oversee operation of the system (NBPTS 1991). The Interstate New Teacher Assessment and Support Consortium (INTASC), which was formed by a consortium of state education agencies, higher education institutions, and national educational organizations, has focused on the other end of the continuum: new teachers. INTASC has begun to develop standards and performance-based assessments useful for judging competent entry-level teaching and for guiding the professional development of early career teachers (INTASC 1991).

Both sets of teachers' standards are compatible with each other, and both are directly linked to the national standards for student performance in specific content areas. The standards for new teachers developed by INTASC have been adopted or adapted for use by 14 states and are being used in several additional states as a basis for evaluating their systems for licensing (INTASC 1994).

Policy efforts also have been initiated to infuse standards-based conceptions of teacher preparation into higher education and teacher training institutions. Many educators view the process of program accreditation as the most effective lever for bringing about desired changes. The National Council for the Accreditation of Teacher Education, which has accredited teacher education programs for many years in cooperation with state agencies, has taken steps in this direction. Recently, it has incorporated performance standards developed by the aforementioned INTASC in the program approval process (Darling-Hammond 1994a).

Conclusion

The central question motivating this chapter is whether the K-12 education system in the United States is doing a good job of providing students with a solid foundation in mathematics and science in order to prepare them for work or continuing study, or simply to be literate members of society.

The answer depends on the perspective taken. From the perspective of curriculum, national and cross-national studies give somewhat different answers. National trend studies suggest that U.S. schools are doing a better job of addressing long-standing inequities in the mathematics and science preparation provided to students in different demographic groups. Compared with the late 1970s and early 1980s, higher proportions of male and female students now complete the core college preparatory courses in mathematics and science, and more black and Hispanic students do so as well. On the other hand, as recently as 1994, a significantly larger fraction of white than black and Hispanic students completed advanced courses in mathematics and science, and more male than female students completed physics. Therefore, there are still substantial inequities to be overcome.

International comparisons suggest that U.S. curricula are lacking in depth and focus. The content of the science curriculum is within the international norms for grades 4, 8, and 12. But relative to science curriculum documents and textbooks in other countries, U.S. schools provide too much repetition, too many topics to be learned, and too little coverage of core science topics.

These limitations are even more characteristic of the mathematics curriculum. There are indications as well that at least the eighth grade mathematics curriculum is pitched at a lower level than in other countries. U.S. curriculum guides and textbooks emphasize topics related to whole numbers and fractions while in most other countries, students are studying more topics in geometry and algebra. Cross-national observations of what takes place in eighth grade mathematics classrooms confirm these findings. Lesson goals and the activities provided to support those goals reflect quite limited cognitive expectations. More often than not, the goal is for students to learn specific skills rather than develop a deep understanding of mathematics.

From the perspective of achievement, national and crossnational studies again point to somewhat different conclusions. Following declines in the 1970s, the performance of U.S. students improved in basic skill areas. Nine- and 13-year-olds are scoring higher on mathematics and science assessments than they did in 1973, while 17-year-olds' performance in 1996 was about the same as in 1973. Although progress has not been substantial in the 1990s, U.S. students have lost no ground. Achievement also improved from 1990 to 1996 in mathematics assessments geared to national mathematics standards. And analyses of the performance of girls and boys in the 1990s show few meaningful differences.

But students of different demographic backgrounds are not achieving at the same levels. Asian Americans and Pacific Islanders and white students outperformed black, Hispanic, and Native American students—even when comparisons correct for the disparities in the courses students have taken. Standards-referenced science assessments introduced in 1996 are too different from earlier tests to permit comparisons with earlier years. But the same pattern of ethnic differences was observed in science as in mathematics.

Findings from the most recent international studies of achievement are mixed, depending on subject matter and grade. Better performance was demonstrated by U.S. fourth grade than eighth grade students when compared with other countries. They scored above the international average in mathematics and well above the international average in science. Eighth grade students performed above the international average in mathematics. Because of differences in the ways earlier international comparisons were conducted, it is difficult to tell if U.S. students are performing comparatively better or worse than they did in previous years. Although the relative standing of U.S. fourth grade students in science has gone up compared with earlier studies, it cannot be said definitively that this represents a real change in standing.

Returning to the original question: what do these findings suggest about the progress and quality of U.S. education? First, they show that the mathematics and science education of students is improving somewhat in terms of equity and excellence—the dual goal of educational reforms. Second, there is much room for improvement, and we are still far from reaching our national goal of being first in the world in mathematics and science. Third, students are not yet performing at the levels of expectation recommended by the mathematics and science standards. Fourth, the curricula could better define and focus on core content in mathematics and science as recommended by the standards. And fifth, teachers could better help students develop a genuine understanding of mathematics and science by engaging them in active tasks that challenge their intellectual capabilities. On the whole, although progress has been made, our schools and school districts will have to do much more if students are to be well-prepared for a future that demands that we, as a nation, have a citizenry solidly grounded in mathematics and science.

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Chapter 2 Higher Education in Science and Engineering

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Highlights

WORLDWIDE INCREASE IN S&E EDUCATIONAL CAPABILITIES

- ♦ From the mid-1980s to the mid-1990s, the number of first university degrees in higher education in science and engineering (S&E) increased rapidly in Asia and Europe, and slowly in North America. During this period, first university degrees in S&E grew at an average annual rate of 4.8 percent among 16 European countries, at 4.1 percent among 6 Asian countries, and at 1.3 percent among North American countries.
- ♦ The increase in S&E degree production in Asia is driven by expanding access to higher education for large or growing populations. Developing countries such as India and China have large populations in their college-age cohorts and increasing participation rates in postsecondary education. The increase in S&E degree production in Europe is driven by expanding access to higher education in the face of a declining student population.
- ♦ A higher percentage of the college-age population in selected Asian countries than in Europe or North America earns university degrees in the natural sciences and engineering (NS&E). In Japan, Singapore, South Korea, and Taiwan, between 6 and 7 percent of 24-year-olds earn NS&E degrees, compared to between 4 and 5 percent of 24-year-olds in Western Europe and North America.
- ♦ In Europe, Asia, and North America, women have been particularly successful in earning degrees in the natural and social sciences. By 1995, women earned close to half of the natural science degrees in higher education institutions in several countries, including the United Kingdom, Italy, the United States, and South Korea. Women in the three regions have also earned the majority of first university degrees in the social sciences, but are considerably less likely to earn degrees in engineering.

CHARACTERISTICS OF U.S. HIGHER EDUCATION INSTITUTIONS

- ♦ The United States has a large and diversified set of institutions of higher education that provides a college or university education to over one-third of the U.S. college-age population. The country has one of the most open education systems in the world. Other countries are also broadening educational access and expanding their graduate programs, particularly in S&E fields.
- ♦ After several decades of continual and rapid expansion of higher education in the United States, enrollment fell for the first time in 1993; it has continued to decline each year since. This decline is partially based on demographics: the U.S. college-age population declined from 22 million in 1980 to 17 million in 1995. The decline in the college-age population was offset for over a

decade by expanded access to higher education for all subpopulations, particularly women and minorities, and enrollment by larger numbers of older students. By 1993, however, overall enrollment began to decline.

Undergraduate S&E Students and Degrees in the United States

- ♦ The trend of increasing enrollment of underrepresented minority students in undergraduate programs has persisted for over a decade and accelerated in the 1990s. Black enrollment increased 3.6 percent annually in the 1990s, reaching 1.3 million in 1995. Hispanic enrollment in higher education increased at an even faster rate during this period (7.1 percent annually).
- ♦ In 1995, at the community college level, over half (57.8 percent) of the enrollment in mathematics classes was for remedial level courses. In 1970, remedial courses in community colleges accounted for about a third of all mathematics courses.
- ♦ The percentage of freshmen in four-year institutions reporting a need for remedial work in mathematics and science has remained high, particularly for women and minorities. In 1995, of those freshmen planning to major in science or engineering, over 16 percent of the males and over 26 percent of the females thought they would need remedial work in mathematics. Among freshman students from underrepresented minority groups planning to major in science or engineering, over 38 percent reported that they would need remedial work in math.
- ◆ The number of earned bachelor's degrees in S&E from U.S. institutions has been increasing for over a decade, but trends differ by field. The number of natural science degrees increased 7.7 percent annually from 1990 to 1995, with stronger than average growth in the biological and environmental sciences, but only modest (2 percent) growth in the physical sciences. Attraction to the computer sciences dropped precipitously from 1986 to 1991, followed by slight decreases to 1995. The number of social science degrees awarded, after record growth between 1986 and 1992 (averaging 6 percent annually), has remained stable for the last four years. Engineering degrees, whose numbers also peaked in 1986, declined until 1991 and then stabilized.
- ♦ In 1995, for the country as a whole, over 5 percent of the college-age population had completed a bachelor's degree in an NS&E field. But in that same year, only about 2 percent of black and Hispanic youth earned a bachelor's degree in an NS&E field. Asian Americans, representing only 4 percent of the U.S. population, have considerably higher than average participation rates: over 12 percent earned an NS&E degree. Low participation rates for blacks and Hispanics changed little throughout the 1980s, although they improved somewhat in the 1990s.

GRADUATE S&E STUDENTS AND DEGREES IN THE UNITED STATES

- ♦ Enrollment in U.S. graduate S&E programs grew for almost 20 years, reached a peak of almost 440,000 students in 1993, and then began to shrink. The decline in enrollment has averaged 1 percent annually. Fewer students enrolling in engineering, mathematics, and the computer sciences account for most of this decline.
- ♦ While women continued a decade-long trend of increased enrollment in graduate S&E programs in 1993, enrollment figures for U.S. white males began a downward trend. In 1977, women represented only one-quarter of S&E graduate enrollment; by 1995, they accounted for 38 percent of enrollment.
- ♦ Progress for underrepresented minorities in S&E graduate enrollment has been very modest. In 1975, they accounted for 3.7 percent of S&E graduate enrollment; by 1995, they accounted for 5.0 percent.
- ♦ In 1992, foreign graduate students reversed their decade-long trend of increased S&E enrollment in U.S. institutions. They decreased their enrollment each year since then. From 1983 to 1992, the number of foreign graduate students increased over 5 percent annually. From 1992 to 1995, their numbers decreased more than 3 percent annually.
- ♦ The number of S&E degrees awarded in the United States at the master's level increased throughout the 1980s, with even stronger growth in the 1990s. The recent growth is mainly accounted for by rising numbers of earned degrees in the social sciences and engineering, with relatively stable numbers in the natural sciences, mathematics, and computer sciences.
- ♦ The proportion of U.S. master's degrees earned by females increased considerably in the last two decades—not only in the natural sciences, but in engineering as well. In 1975, females earned 21.1 percent of the natural science degrees at the master's level and 2.5 percent of the engineering degrees. By 1995, females accounted for 41.0 percent of natural science degrees and 16.2 percent of engineering degrees.
- ◆ Asian Americans earned an increasing number of S&E master's degrees, while the number of such degrees awarded to underrepresented minorities grew only slightly. The number of S&E master's degrees awarded to Asian Americans grew especially in engineering, mathematics, and the computer sciences. The number of S&E master's degrees obtained by blacks grew modestly in most fields, although there was strong growth in the social sciences. Hispanics also earned a modestly increasing number of degrees in the social sciences, as well as in engineering.

- ◆ The number of doctoral degrees in engineering, mathematics, and the computer sciences nearly doubled from 1985 to 1995. Natural science fields—particularly the biological sciences—contributed to the rising number of degrees, with a 30 percent increase.
- ♦ Women accounted for an increasing proportion of S&E doctoral degrees, while underrepresented minorities showed only a slight increase. By 1995, females earned almost half of the doctoral degrees in the social sciences, 38 percent in the biological sciences, and almost 12 percent in engineering. Underrepresented minorities received less than 5 percent of all S&E doctorates awarded in 1995, up slightly from 3 percent in 1977.
- ♦ In the past decade, foreign students have accounted for the large growth in S&E doctoral awards in U.S. universities. The number of foreign doctoral recipients in U.S. universities doubled in S&E fields from over 5,000 in 1986 to over 10,000 in 1995—an 8.2 percent average annual increase. In contrast, the rate of increase in doctoral degrees to U.S. citizens averaged only 1.9 percent annually.
- ♦ The proportion of foreign doctoral recipients planning to remain in the United States has increased: for the 1992-96 period, over 68 percent planned to locate in the United States, and nearly 44 percent had firm offers to do so. Stay rates differ considerably by place of origin. In 1996, 57 percent of the U.S. S&E doctoral recipients from China and 59 percent of those from India choose to accept employment in the United States. In contrast, only a small percentage of 1996 doctoral recipients from South Korea and Taiwan (24 and 28 percent, respectively) accepted employment offers in the United States.
- ♦ From 1990 to 1994, U.S. universities provided slightly more than half of their postdoctoral appointments to non-U.S. citizens. However, like the recent decline of foreign graduate enrollments in S&E in U.S. universities, there has been a slightly smaller proportion of foreign postdoctoral appointments and a slightly increasing number of appointments to U.S. citizens, particularly in the sciences. Foreign postdoctoral recipients still receive the majority of such research positions within U.S. universities in engineering.
- ♦ One indicator of mobility of S&E personnel in the world is the proportion of foreign-born faculty in U.S. higher education. In 1993, foreign-born faculty in U.S. higher education accounted for 37 percent of the engineering professors and 27 percent of the mathematics and computer science teachers. These faculty are mainly from Asia and Europe, with the largest numbers coming from India, China, the United Kingdom, Taiwan, Canada, and South Korea.

INTERNATIONAL COMPARISONS OF S&E TRAINING

◆ Europe leads North America and Asia in S&E doctoral degree production. In 1995, doctoral degrees awarded in S&E fields by Western and Eastern European institutions totaled 45,647—about 60 percent higher than the North American level and almost three times as many as the number recorded for Asian countries. ♦ While graduate S&E programs are expanding rapidly in Asia, women have not yet entered those programs in large numbers. Women still earn only a small fraction of the doctoral S&E degrees issued in Asia. In 1995, women in South Korea and Taiwan earned only 7 and 9 percent, respectively, of total S&E degrees at the doctoral level.

Introduction

Chapter Overview

Scientific discoveries, technological innovation, and the information revolution had a tremendous influence on U.S. society and the global economy in the late 20th century. These forces will have still greater roles in shaping the emerging knowledge society that will mature worldwide in the 21st century. The U.S. higher education system has facilitated this knowledge explosion and contributed, directly and indirectly, to the worldwide diffusion of science and engineering (S&E) knowledge. Consequently, encouragement of S&E education is a key element of the economic growth strategies of many countries around the world.

This chapter on higher education in S&E discusses trends that demonstrate the increasing globalization of S&E capabilities. At the undergraduate level, the globalization of science and technology has domestic implications for further openness in access to higher education in S&E fields for women and minorities, who will comprise the majority of the labor force in the 21st century. The increasing global capabilities for graduate S&E education have implications for the large international component of U.S. graduate S&E programs. This chapter includes indicators of the increase in capabilities for S&E education at the bachelor's and doctoral levels in three world regions: Asia, Europe, and North America. It also includes domestic indicators of current achievement in earning S&E degrees, both at the national level and for women and minorities.

Chapter Organization

This chapter begins and ends with international comparisons that put U.S. higher education indicators in a broader context. The comparisons at the chapter beginning are at the bachelor's level (referred to internationally as "first university degrees"), while those at the end are at the doctoral level. The initial international indicators relate to the number of S&E degrees: the growth rate over time of first university degrees, the proportion of S&E degrees produced among regions, participation rates of college-age cohorts in S&E degrees, differences in participation rates by sex, and the ratio of S&E degrees to total first university degrees by country.

The main body of the chapter focuses on U.S. higher education in science and engineering, including institutions, en-

rollment, and degrees at all levels. To a greater extent than is possible with the international indicators, domestic data illustrate trends in disaggregated fields, show coursetaking behavior at the undergraduate level, and note achievement by women and minorities. The following domestic indicators are disaggregated by race and sex: trends in enrollments, choice of S&E majors, need for remedial work in mathematics and science, participation rates in S&E degrees, and earned degrees at all levels.

Changes in the contributions of international students and faculty are explored in indicators on foreign doctoral students and stay rates in the United States of foreign doctoral recipients, the growth and change of postdoctoral appointments, foreign faculty in U.S. higher education, and reverse flows of U.S.-trained scientists and engineers to Asia.

The final chapter sections present science and technology indicators relating to international mobility. These include international comparisons of foreign student enrollment and comparison of doctoral S&E degree production in three world regions.

Note that trends are presented in terms of both S&E and the natural sciences and engineering (NS&E) throughout this chapter. These designate different aggregations of fields. S&E is the more inclusive term, including all fields; NS&E excludes social and behavioral sciences. Both aggregations are included because trends differ among S&E and NS&E, particularly for women and minority groups (e.g., they are relatively better represented in the social and behavioral sciences). In addition, to make international comparisons more comparable in scope, NS&E is frequently used.

Worldwide Increase in S&E Educational Capabilities

In each country, a number of factors drive student participation in science and engineering. Among these are demographics (the number of college-age students), organizational aspects of the university system (how open—accessible—the system is), how the secondary education system dovetails into higher education, as well as the incentives for studying and staying in S&E as opposed to entering directly into the workforce. These factors combine in different ways in each country to influence the number of S&E students.

¹The natural sciences comprise the physical, chemical, biological, agricultural, earth, atmospheric, and oceanographic sciences, as well as mathematics and the computer sciences.

First University Degrees²

From the mid-1980s to the late 1990s, the number of first university degrees in science and engineering increased rapidly in Asia and Europe and slowly in North America. In this period, first university degrees in S&E grew at an average annual rate of 4.8 percent among 16 European countries, at 4.1 percent among 6 Asian countries, and at 1.3 percent among North American countries.³ When considering only NS&E degrees, the North American degrees declined at an average annual rate of just under 1 percent (NSF 1993 and NSF 1996a), while the European and Asian degrees increased over 4 percent.

In 1995, more than 2.1 million students in these three regions earned a first university degree in science or engineering, up from 1.6 million in 1992.⁴ (See "Degree Data Available for Asia, Europe, and North America.") These 2.1 million degrees were evenly divided among the major fields: approximately 765,000 were earned in the natural sciences, 643,000 in the social sciences, and 739,000 in engineering. (See text table 2-1.)

By 1995, within the Asian region, the number of first university degrees in the natural sciences rose to over 300,000—almost as many as the number of such degrees earned in the European region, and about twice the number earned in the North American region. Within engineering, selected Asian

Degree Data Available for Asia, Europe, and North America

Data availability differs among the countries of these three regions. Trend data on degrees earned in broad S&E fields have been developed for 6 Asian economies—China, India, Japan, Singapore, South Korea, and Taiwan; 16 Western European countries—Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom; and 3 North American countries—Canada, Mexico, and the United States. (See NSF 1993 and NSF 1996a.) Recent degree data covering one year only (1993 or 1994), for selected Central and Eastern European countries and Russia, were obtained from the Organisation for Economic Co-operation and Development (1996). In addition, more of Asia's developing countries—including Indonesia, Malaysia, and Thailand—have begun collecting and reporting their national education statistics to UNESCO's annual survey, providing a more complete picture of the Asian region.

countries produced over 343,000 degrees, 21 percent higher than the number of such degrees in Europe (including Russia), and more than three times the number earned in the North American region. (See figure 2-1, text table 2-1, and appendix table 2-1.)

Asia

Trend data from selected Asian countries show that for China, India, Japan, South Korea, Singapore, and Taiwan, the number of first university degrees in science and engineering fields increased greatly. Between 1975 and 1995, the total

Text table 2-1. First university degrees in S&E, by region: 1995 or most recent year

Field	Three-region total	Asia	Europe	North America
First university degrees, all fields	5,208,205	2,043,677	1,713,423	1,451,105
Science & engineering	2,146,648	926,426	732,263	487,959
Natural sciences	764,820	301,877	309,837	153,106
Social sciences	642,777	280,775	138,896	223,106
Engineering	739,051	343,774	283,530	111,747

NOTES: The requirements for first university degrees in S&E fields are not comparable across or even within the countries included in these three regions, particularly for European universities. For example, Germany includes both university degrees (with an average duration of 7 years) and Fachhochschulen degrees (polytechnics of 4.5 years' average duration) as first university degrees (level 6 in UNESCO classification). Work has been under way for several years at UNESCO, EUROSTAT, and the U.S. Department of Education to refine the levels of higher education for better comparability across countries. See, for example, U.S. Department of Education and National Science Foundation, Mapping the World of Education: The Comparative Database System (CDS) (Washington, DC: 1994). A new UNESCO survey will be designed and implemented by the end of this decade. See appendix table 2-1 for countries included in each region.

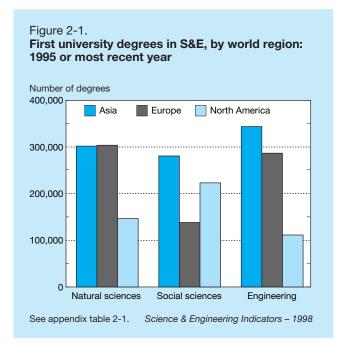
See appendix table 2-1.

Science & Engineering Indicators – 1998

²Data in this section are taken primarily from the National Science Foundation, Science Resources Studies Division, Global Database on Human Resources for Science.

³A first university degree refers to completion of an undergraduate postsecondary degree program. These degrees are classified as level 6 in the International Standard Classification of Education, although individual countries use different names for the first terminal degree: e.g., *laureata* in Italy, *diplome* in Germany, *maitrise* in France, and bachelor's degree in Asian countries and the United States.

⁴Data were available from fewer countries for the 1992 regional totals. The 1995 European data include some Eastern European countries as well as Russia. (See appendix table 2-1.) See NSB (1996), appendix table 2-1, for countries included in 1992 regional totals.



number of degrees in the natural sciences earned by students from these countries nearly doubled, while those in engineering more than tripled. (See NSF 1993 and appendix table 2-2.) In the last decade, the average annual growth rate in earned NS&E degrees in Asia was 4.2 percent. In contrast, in the North American region, the number of NS&E degrees declined at an average annual rate of 0.9 percent from 1986 to 1994. (See "Undergraduate S&E Students and Degrees in the United States" for further information on U.S. degree trends.)

The biggest increase in NS&E degrees in the Asian region came as a result of China reopening its universities and expanding its institutions of higher education in the 1980s. (See "Growth in Institutions of Higher Education in Asia.") From 1985 to 1995, earned degrees in the natural sciences rose from 28,000 to over 54,000; engineering degrees rose from 73,000 to almost 150,000. China has a strong commitment to higher education in the natural sciences (stressing the applied side of chemistry, physics, and biology); in 1995 it produced more than twice as many bachelor's degrees in these fields as did Japan. (See appendix table 2-2.)

China has the largest number of NS&E first university degree recipients at 203,238, followed by India at 176,036, and Japan at 127,971. However, with the large populations of China and India, the number of earned degrees represents a relatively small proportion of the college-age cohort. (See "Increasing Participation Rates in NS&E Degrees" later in this chapter and appendix table 2-1.)

China's rapid expansion of S&E degrees is partly explained by demography (its 20- to 24-year-old population equals 100 million) and partly by a national policy to extend higher education—particularly in science and engineering—in support of national economic development.

Europe

The increase in the number of S&E degrees awarded by higher education institutions in European countries is also noteworthy. (See "Growth in Institutions of Higher Education in Europe.") From 1975 to 1995, the Western European countries⁵ collectively more than doubled their annual production of first university degrees in S&E. The number of natural science degrees increased from approximately 56,000 in 1975 to more than 150,000 in 1995. The number of social science degrees increased from approximately 50,000 in 1975 to over 80,000 in 1995. And the number of engineering degrees rose from 51,000 in 1975 to more than 137,000 in 1995. (See NSF 1996a and appendix table 2-1.)

The European expansion of higher education in science and engineering, and heavy investments in research and development (R&D), underpin a broader effort to maintain and enhance Europe's economic vitality through the European Union (EU). The EU is attempting to integrate the S&E research community and make the region's high concentration of science resources even more productive in order to increase competitiveness at the European and global levels (NSF 1996a).

Germany, France, and the United Kingdom account for most of this expansion of higher education; students from these three countries earned more than 60 percent of the first university degrees awarded in NS&E in Europe. The United Kingdom democratized its access to higher education through curricular reform of upper secondary education, providing the academic background for more students to continue in school past 16 years of age, with increased options to study science and subsequently enter the university. These reforms resulted in a significant increase in the number of NS&E degrees earned. Further, the number of U.K. degrees sharply increased in 1992 due to the reclassification of colleges and polytechnics as universities. In addition to a gradual expansion of higher education, a much larger number of engineering degrees in Germany resulted from the 1989 reunification of the former West Germany with the former East Germany, which—like many Central and Eastern European countrieshad focused much of its higher education on engineering. (See NSF 1996a and appendix table 2-1.)

North America

Trend data on Canada, Mexico, and the United States show a decline in earned undergraduate degrees in NS&E from 1986 to 1994.⁶ This decline is partly accounted for by changes in the demographics of the United States and Canada: specifically, the decline in college-age population that began in the mid-1980s. (See appendix table 2-3.) Initially, this downturn in the college-age cohort was offset by increasing access to higher education among all subpopulations. However, this broader access and increased enrollment in higher education did not result in larger numbers of bachelor's degree

⁵Western European countries are those within the European Union and the European Free Trade Association. (See appendix table 2-1.)

⁶Data are from NSF (1997a), unpublished tabulations.

Growth in Institutions of Higher Education in Asia

The expansion of higher education institutions in Asia, particularly for graduate programs, has been financed by government (Japan), by industry (South Korea), and through international loans (China).

Japan. Japan greatly expanded its institutions of higher education in the 1950s. By 1955, there were over 100 public institutions, including both local and national universities. The number of public institutions has not significantly increased since then. In all, 25 national universities and 15 local universities have been opened in the last 40 years. In contrast, the number of private institutions has increased rapidly in the last few decades, reaching over 400 in 1995, and accounting for around 75 percent of all higher education institutions (Monbusho 1995). National universities, however, dominate in the production of doctoral degrees, accounting for 85 percent of NS&E degrees (Monbusho 1995).

About 30 of Japan's national universities are considered research universities. In the 1970s, the government Ministry of Education, Science, and Culture began building national inter-university research institutes open to all university researchers. These provide large-scale, well-equipped research facilities that can be used for international collaboration in specific fields. The first of these inter-university research institutes was the National Laboratory for Higher Energy Physics. These institutes, now numbering 15, have the same status as national universities (Monbusho 1995).

The main science funding agencies in Japan have sharply increased the amount of competitive research funding to universities to improve research facilities and personnel. About a half-dozen research institutes have received large five-year infusions of funds to enable them to become centers of excellence in specialized fields—e.g., brain research, material science, and econometrics (NSF 1997c).

South Korea. The most prestigious institutes of higher education in South Korea are those few national universities that survived the 1905-45 Japanese occupation. However, a substantial network of new higher educational institutions was created after the Korean War, consisting of 134 colleges and universities, and 152 junior colleges. The latter play a key role in the education of scientists and engineers. In fact, much of the recent rise in postsecondary educational attainment is seen at the junior college level, where enrollment nearly doubled between 1990 and 1996 (Government of the Republic of Korea 1996).

South Korea has also expanded graduate S&E programs. In the 1980s, the Korean Advanced Institute of Science and Technology was established to increase support for post-graduate training within South Korea. More recently, Pohang University of Science and Technology was established by the industrial giant, Pohang Iron and Steel Corporation, much as institutions such as Stanford and Carnegie-Mellon were founded by early U.S. industrialists.

China. In the 1980s, the extensive infrastructure for graduate training in China was strengthened, after having been greatly disrupted during the late 1950s and the Cultural Revolution of the 1960s. China's policy of modernization through science and technology resulted in a

massive investment in higher education institutions, particularly to increase enrollments in S&E at the undergraduate and graduate levels. The expansion and upgrading of such institutions were partially financed by a series of international loans from the World Bank; from 1981 to 1991, these loans totaled \$1.2 billion. (See text table 2-2.)

China specifically requested international development assistance loans for higher education as part of its economic plan to bolster its high-technology manufacturing sectors. The loans improved research instrumentation and computing facilities, allowed both senior scholars and younger students to study abroad, and provided for several hundred international advisors to assess departments and advise on curricular reform (Hayhoe 1989).

Part of China's strategy was to improve the quality of teaching and research in higher education by sending selected students to study in foreign universities, especially in NS&E fields. At first, most students and research scholars were government supported and returned to China after their studies. Between 1979 and 1988, approximately 19,500 Chinese scholars and graduate students who had studied in the United States returned to China; they subsequently became an important component of China's science and technology resources (Orleans 1988). Currently, only a small fraction of Chinese foreign students are government supported, and return rates to China are low. (See "Stay Rates of Foreign Doctoral Recipients in the United States" later in this chapter.)

There are more than 1,000 higher education institutes in China. Seventy of them provide four-year university programs; 43 are comprehensive universities. In 1988, about 86 of China's higher education institutions were singled out as centers of excellence for priority funding (NSF 1993).

Text table 2-2.

Recent World Bank education projects in China
(Millions of current U.S. dollars)

Project topic	Total	Loan	Credit	Years
University development I Agricultural education/	200	100	100	1981-86
research I	75		75	1982-88
Polytechnic/TV university	85		85	1983-89
Agricultural education II Rural health and medical	69	45	24	1984-89
education	85		85	1984-89
Agricultural research II	25		25	1984-89
University development II	145		145	1985-90
Provincial universities	120		120	1985-90
Technical education	130		130	1987-91

NOTE: Loans are funded by the World Bank's International Bank for Reconstruction and Development at commercial rates. Credit is provided by the World Bank's International Development Association; this funding is interest free and has lengthy repayment terms.

SOURCE: R. Hayhoe, *China's Universities and the Open Door* (Armonk, NY: M.E. Sharpe, Inc., 1989).

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Growth in Institutions of Higher Education in Europe

In the 1960s, the accelerated pace of European economic development created a demand for more skilled labor, and the expansion of the middle class caused a great demand for higher education. Governments in Europe responded to these pressures by forming so-called "non-university" tertiary level institutions, such as the *Instituts Universitaires de Technologie* in France in 1966, polytechnics in the United Kingdom in 1969, and the *Fachhochschulen* in Germany in 1971 (Academia Europea 1992). The small number of students in secondary and higher education in these countries began to expand. Similar institutions arose throughout other Western European countries during this period, thus broadening the student base in higher education. The largest numbers of institutions are found in Germany, France, and the United Kingdom.

Germany. German higher education takes place at 251 institutions, among them 125 Fachhochschulen and 70 universities, including 6 private universities. Only university graduates may continue their studies through doctoral programs. The university degree in Germany requires a minimum of 4 years of study; the average length of undergraduate study is 6.5 years. This lengthy first university degree reflects both the quality of university education and the great overcrowding of universities, a phenomenon that occurs throughout Europe. University education is funded by the federal government and the Lander (states), and the numbers of institutions and faculty positions have not expanded in proportion to the increasing number of students (Von Friedeburg 1991). The German Government has established 26 new Fachhochschulen in the former East Germany to create a more highly skilled labor force and to foster economic growth in that region (Government of the Federal Republic of Germany 1994).

France. Institutions of higher education in France include universities; technical institutes; and Grandes Écoles of engineering, business, and administration. The vast majority of students are in universities; only 90,000 students attend the prestigious Grandes Écoles (Feldman and Morelle 1994). Postsecondary two-year technology programs grew rapidly in the 1980s at the University Institutes of Technology and the Sections de Technicien Supérieur (Charlot and Pottier 1992).

United Kingdom. Until recently, higher education institutions in England and Wales were divided into three sectors: universities, polytechnics, and colleges. Most provide three-year degrees (following a 13-year elementary and secondary program), although degree awards in NS&E fields usually take four years. The universities are the longest established of the three sectors. Colleges were founded in the late 19th century for training personnel for local employers. Thirty polytechnics were created in the 1960s to broaden access to higher education for groups traditionally underrepresented. They originally were to have a vocational focus, but the course offerings of the polytechnics have gradually become similar to those of universities. In 1992, most polytechnics attained university status. The 46 existing universities retained their role as prime providers of research and still account for the large majority of natural science degrees. Only about half of all engineering and computer science degrees are obtained in universities, however; the other half are obtained in polytechnics and specialized colleges (Tarsh 1992).

(For more information on institutions of higher education in Germany, France, and the United Kingdom, see NSF 1996a.)

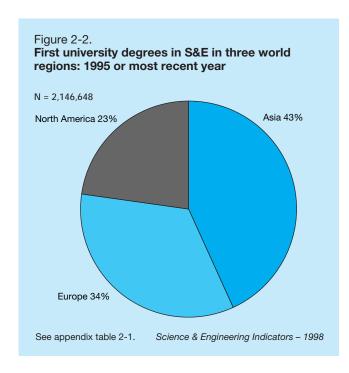
completions in S&E fields. In the United States, the ratio of NS&E degrees to total first university degrees has declined from 21 percent in 1987 to 15 percent in 1995. (See NSF 1993 and appendix table 2-6.) In contrast, Mexico has had an increasing college-age cohort and an expansion of earned university degrees from 1980 to 1992, particularly in engineering. Recent data from Mexico (1993 and 1994) show a decline in NS&E degrees, but this is due to major changes in taxonomies used in the classification of NS&E degrees and in the graduation requirements within Mexico's university system. (ANUIES 1996b.)

Regional Proportions of S&E Degree Production

Opportunities for S&E education are increasing throughout the world, consequently, the U.S. proportion of the total is decreasing. In 1995, earned degrees in S&E in the North American region represented 23 percent of the three-region total. (See

figure 2-2.) The United States represented less than 18 percent of such earned degrees. In considering only NS&E fields (excluding the social sciences), the U.S. proportion is even smaller.

Even though the lack of time-series data for all countries in these regions prevents a statistically sound comparison of regional proportions from an earlier period, the higher rate of change in the distribution of S&E degrees over time in other world regions has implications for the United States and other countries. The global diffusion of S&E education also has implications for the U.S. higher education system. Other countries' increasing capacity to educate in advanced levels of S&E helps explain the decline in foreign student enrollment in engineering programs in the United States. (See "Bachelor's Degrees in S&E" and "Trends in Graduate Enrollment" later in this chapter.) In addition, the continuing expansion of global capacity for S&E education has implications for all nations, since it indicates an increased potential for technological and economic development worldwide.



Reasons for the Global Increase in S&E Education

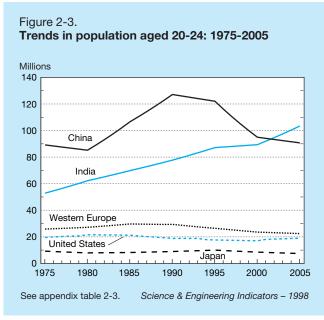
Demographics

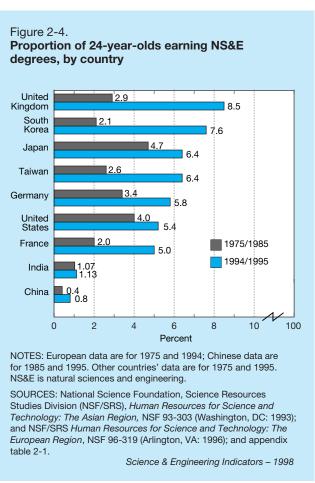
The increase in S&E degree production in Asia is driven by the expansion of access to higher education for large or growing populations. Developing countries such as India and China have large populations in their college-age cohort and increasing participation rates in postsecondary education, while the industrialized countries of Japan, Western Europe, Canada, and the United States have declining student populations. Trend data on China's 20- to 24-year-old population show a decline from 1990 to 2005, but the number in this age segment is over 100 million for 1998. India's college-age cohort will have increased to 88 million by 1998. In contrast, the college-age population in Western European countries as a whole has declined from 30 million in 1985 to 25 million in 1998, and will continue to decline until 2005. The U.S. college-age cohort has been decreasing since 1980, and will continue to do so until 2000, when this age segment will slowly begin to rise. Japan's college-age population (10 million in 1995) will decrease by 30 percent in the next 15 years. (See figure 2-3 and appendix table 2-3.)

Increasing Participation Rates in NS&E Degrees

Taiwan and South Korea dramatically increased their production of NS&E degrees from about 2 percent of their 24-year-olds in 1975 to 6 and 7 percent, respectively, in 1995. (See figure 2-4.) Japan has consistently had a high percentage of its 24-year-olds completing NS&E degrees since the 1970s; a slight decline in NS&E recipients in the late 1980s was followed by yet more growth in the 1990s. (See appendix table 2-1 for 1995 data and NSF 1993 for trend data on Asian countries.)

Asia's two population giants, India and China, have low attainment rates of NS&E degrees. India, with its huge, growing





population, is maintaining its participation rate of 1.1 percent. In 1985, just under 0.9 percent of China's college-age population earned a bachelor's degree, and approximately 0.5 percent earned a degree in an NS&E field. Within a decade, these percentages rose to 1.3 percent with a bachelor's degree and 0.8

percent with an NS&E degree, although participation rates are still far lower than those for developed countries. (See appendix table 2-1; see NSF 1993 for trend data on Asian countries.) If China continues to increase its participation rate in NS&E degrees, and India can maintain its current rate with a growing population, the world stock of science and engineering graduates will be greatly augmented, and the U.S. share of S&E degrees will be reduced.

A declining pool of college-age students in Europe has not resulted in declining numbers of NS&E degrees, as has occurred in the United States. Rather, participation rates in higher education and NS&E degrees, previously low, have grown to more than offset the declining population. In Finland, for example, 9 percent of the college-age cohort obtains a university degree in the natural sciences or engineering—one of the highest participation rates in the world.

Differences in Participation Rates by Sex

The growth in participation rates in NS&E degrees differs considerably for males and females across countries. Japan shows the largest disparity in completion of NS&E degrees by males and females of college age. In 1995, more than 11 percent of males in the college-age population earned an NS&E degree. One percent of Japan's females earned such a degree. South Korea has a similarly high percentage of college-age males earning an NS&E degree, and 4 percent of its female college-age population earned such a degree. In the United States, 7 percent of college-age males earned an NS&E degree, as did almost 4 percent of females. (See appendix table 2-4.)

In countries of the three world regions examined, women have been particularly successful in earning degrees in the natural sciences and the social sciences. By 1995, women earned 50 percent of the natural science degrees in higher education institutions in the United Kingdom, 54 percent in Italy, 47 percent in the United States, and 44 percent in South Korea. In most countries in the three regions, women have also earned the majority of first university degrees in the social sciences. The notable exceptions are Japan and South Korea, where women earn only a modest proportion of social science degrees—19 and 27 percent, respectively. Women in all countries are considerably less likely to earn degrees in engineering. (See appendix table 2-5.)

Focus on S&E in Higher Education

Part of the reason for this rapid Asian growth has been the greater focus on these fields within Asian universities, with high quotas set for enrollments in these departments. Reflecting China's strategy to develop its economy through science and technology (see "Growth in Institutions of Higher Education in Asia"), 72 percent of its first university degrees are earned in S&E fields. In addition, about 67 percent of Japanese degrees and 46 percent of South Korean were in these fields. Among European countries, 46 percent of first university degrees in Germany and Finland are in S&E. Russia and Central and Eastern European coun-

tries are similarly focused on science and engineering. In contrast, less than one-third of first university degrees (bachelor's degrees) in the United States are earned in S&E. (See appendix table 2-6.)

Characteristics of U.S. Higher Education Institutions

The United States has a large and diversified set of institutions of higher education that provides a college or university education to over one-third of the U.S. college-age population. (See appendix table 2-1.) This access to higher education ranks the United States among those countries with the most open education systems in the world.

In the United States, there were 3,681 (1,594 public and 2,087 private) institutions of higher education in 1995 (HEP 1997). These institutions enrolled 14.4 million students at all degree levels (associate, bachelor's, master's, and doctoral) in that year and awarded 2.2 million degrees, almost one-quarter of which were in S&E. (See figure 2-5.) The Carnegie Foundation for the Advancement of Teaching has classified these institutions into 10 categories based on the size of their baccalaureate and graduate degree programs, the amount of research funding they receive, and—for baccalaureate colleges—their selectivity. Following is a brief description of these categories.

- ♦ Research universities I. These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year, and receive \$40 million or more annually in federal support.
- ♦ Research universities II. These institutions are the same as research I, except that they receive between \$15.5 million and \$40 million annually in federal support.
- ♦ *Doctorate-granting I.* In addition to offering a full range of baccalaureate programs, the mission of these institutions includes a commitment to graduate education through the doctoral degree. They award 40 or more doctoral degrees annually in at least five academic disciplines.
- ◆ Doctorate-granting II. These institutions are the same as doctorate-granting I, except that they award 20 or more doctoral degrees annually in at least one discipline or 10 or more doctoral degrees in three disciplines.
- ◆ Master's (comprehensive) universities and colleges I. These institutions offer baccalaureate programs and, with few exceptions, graduate education through the master's degree. More than half of their baccalaureate degrees are awarded in two or more occupational or professional disciplines, such as engineering or business administration.

⁷The Carnegie classification is not an assessment guide, nor are the distinctions between classification sublevels (e.g., research I and research II) based on institutions' educational quality. Baccalaureate college I institutions exercise more selectivity regarding students than do baccalaureate colleges II, but in general the Carnegie categories are a typology, not a rank ordering.

Figure 2-5. U.S. higher education in 1995: Students, institutions, and degrees Where are they enrolled? 2,771,455 in 126 research I & II institutions 1,297,354 in 109 doctorate-granting I & II institutions 3,187,136 in 531 master's universities and colleges I & II 14.4 million 1,076,770 students in 625 enrolled liberal arts I in 3,600 5,406,744 in 1,473 two-year institutions and II institutions.. 496,508 in 352 specialized How many degrees do they obtain? institutions 561,744 236,812 ...earn 2.2 million degrees... 563,831 174,966 545,801 66,841 How many degrees in S&E? 231,453 ...of which 523,000 are in S&E: ◆ 25,921 doctorates ♦ 94,309 master's degrees ♦ 378,148 bachelor's degrees 72,062 ◆ 24,228 associates degrees 129,923 52,222 24,228 7,458

NOTE: This figure represents relative sizes of enrollments and degrees within Carnegie categories of institutions in 1993. It does not depict the dynamics of higher education or the movement of students among institution types prior to graduation.

See appendix tables 2-8, 2-9, 2-10, and 2-18.

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The U.S. Higher Education System

The U.S. system of higher education is characterized at the undergraduate level by diverse institutions that provide flexible access to higher education for a broad range of U.S. citizens. At the graduate level, the system serves not only U.S. students but international students as well. Demographic changes (for example, a pending upturn in the population of college-age students, with higher percentages of minorities underrepresented in S&E), the increasing capabilities of other nations, and job-seeking experiences of recent graduates are prompting a reexamination of the U.S. system of higher education.

At the undergraduate level, the U.S. system provides access for a broad cross-section of citizens. About onethird of the college-age cohort completes a college or university education in some field. Although some European countries are approaching this high level of access, the European region as a whole reaches only about half that proportion of its college-age cohort. Contributing to this broader U.S. access is the expansive institutional base of U.S. higher education, which allows for flexibility in transferring among institutions and diverse attendance patterns. Over one-third of the 15 million students in U.S. higher education are in community colleges. These institutions let students transfer credits to four-year colleges and universities; they also provide considerable remedial coursework for students who were not well-served by, or well-motivated during, their high school education. (Chapter 1 discusses this phenomenon, with particular reference to middle and high school teachers teaching out of their field, especially in math and science.)

This expansive institutional base, however, is also characterized by uneven quality and highly differential resources. Many minority students are in community colleges; although this can facilitate their continuation in the higher education system, this level of the system is the most poorly funded and has the worst track record for graduation. Only a small percentage of minority students or students from poor families completes an associate degree in an S&E field and subsequently enters a four-year institution. Moreover, since most mathematics courses at the community college level are remedial, they are not transferable to four-year institutions. This route in the U.S. higher education system has not yet resulted in commensurate representation of minority groups in earned degrees in science, mathematics,

and engineering. (See "S&E Human Capital Development: Continued Unevenness Across Demographic Groups" later in this chapter.)

With its blend of advanced coursework and research experience, U.S. graduate education in S&E is considered to be among the best in the world. In the last 10 years, U.S. graduate programs have expanded, particularly at the doctoral level. Academic R&D has also grown during this period, and an increasing number of foreign students have enrolled in U.S. graduate S&E programs. Between 1985 and 1995, the number of doctoral degrees awarded in engineering, mathematics, and the computer sciences doubled. Much of this growth was due to foreign doctoral recipients, many of whom earned their S&E degrees while supported as research assistants. Postdoctoral positions increased at almost the same rate, and foreign students earned an increasing proportion of these appointmentsslightly more than half by the 1990s. (See chapter 5, "Integration of Research With Graduate Education.") Beginning in 1993, however, foreign student enrollment in U.S. graduate S&E programs experienced a decline, which, if it continues, will reduce the proportion of S&E degrees and postdoctoral appointments awarded to foreign students.

Decisionmakers throughout the U.S. higher education system are examining both undergraduate and graduate levels to broaden participation of all groups in science and engineering, and to broaden career choices for those with advanced degrees. At the undergraduate level, a revitalization of science and mathematics curricula is aimed at better teaching of all students, enhanced teacher preparation for K-12 programs, and greater retention of students in S&E departments. Educators are forming partnerships between the faculties of two- and four-year schools to improve academic courses at community colleges and establish agreements for transferring credits. In graduate education, the appropriateness of current training for careers in industry as well as in academia is being examined.

Reforms in U.S. higher education are particularly important in light of ongoing demographic changes. A two-decade-long decline in the college-age cohort in the United States reduced the traditional college-age population from 22 million in 1980 to 17 million in 1995. This declining trend is expected to reverse itself in the year 2001. The projected increasing student population will then create a demand for yet further expansion of the U.S. higher education system.

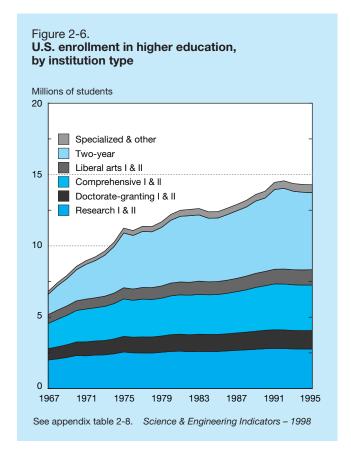
All of the institutions in this group enroll at least 2,500 students

- ♦ Master's (comprehensive) universities and colleges II.

 These institutions are the same as master's universities and colleges I, except that all of the institutions in this group enroll between 1,500 and 2,500 students.
- ♦ Baccalaureate (liberal arts) colleges I. These highly selective institutions are primarily undergraduate colleges and award more than 40 percent of their baccalaureate degrees in liberal arts and science fields.
- ♦ Baccalaureate (liberal arts) colleges II. These institutions are primarily undergraduate colleges that award less than 40 percent of their degrees in liberal arts and science fields. They are less restrictive in admissions than baccalaureate colleges I.
- Associate of arts (two-year) colleges. These institutions offer certificate or degree programs through the associate degree level and, with few exceptions, offer no baccalaureate degrees.
- ◆ Professional schools and other specialized institutions. These institutions offer degrees ranging from the bachelor's to the doctorate. At least half of the degrees awarded by these institutions are in a single specialized field. These institutions include theological seminaries, bible colleges, and other institutions offering degrees in religion; medical schools and centers; other separate health profession schools; law schools; engineering and technology schools; business and management schools; schools of art, music, and design; teachers' colleges; and corporate-sponsored institutions.

After several decades of continual and rapid expansion of higher education in the United States, enrollment fell for the first time in 1993; it has continued to decline each year since then. (See figure 2-6 and appendix table 2-8.) This decline is partially based on demographics: the U.S. college-age population declined from 22 million in 1980 to 17 million in 1995. (See appendix table 2-3.) However, the decline in the college-age population was offset for over a decade by expanded access to higher education for all subpopulations, particularly women and minorities, and enrollment by larger numbers of older students. The U.S. college-age cohort will again increase beginning in 2001, and higher education enrollments are expected to increase concurrently.

A diverse spectrum of institutions contributes to the S&E degrees in the United States. The country's 126 research universities provide the majority of engineering degrees and a large proportion of natural and social science degrees at both the graduate and undergraduate levels. (See figure 2-7.) In 1995, research universities enrolled only 19 percent of all students in higher education, but produced over 46 percent of all S&E degrees. (See appendix tables 2-8 and 2-9.) In contrast, the associate of arts colleges enroll a large proportion of all students in higher education, but account for only a small percentage of S&E degrees. In 1995, only about 10 percent of the over 5.4



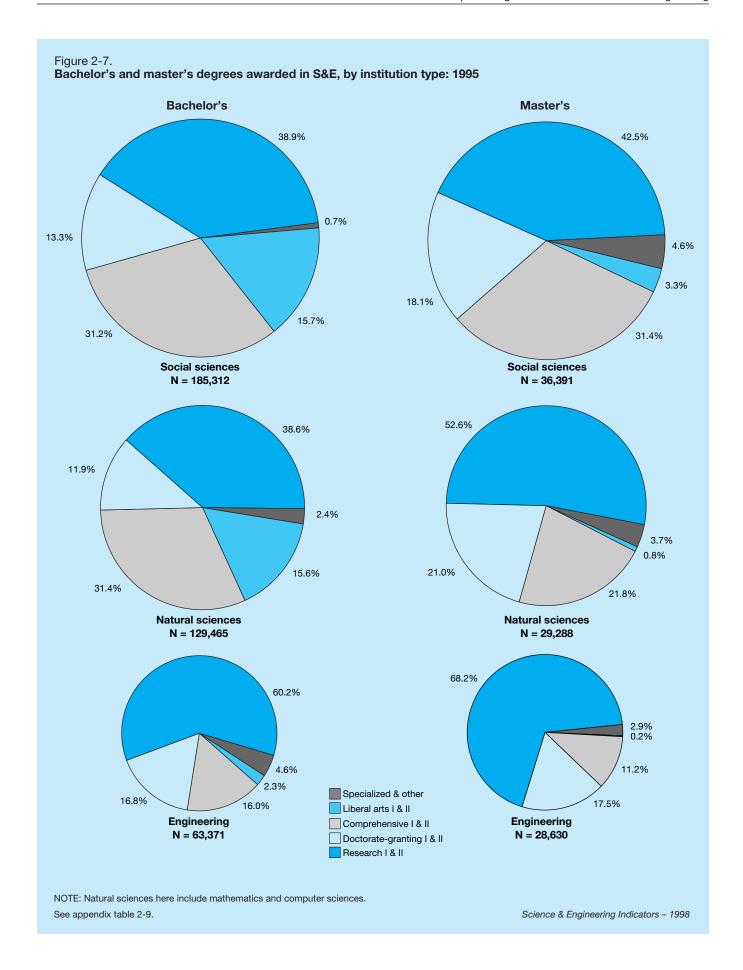
million students attending junior colleges completed an associate degree—less than 1 percent in an S&E field. These two-year colleges, however, provide continuing education and flexibility in the U.S. higher education system, allowing students to complete needed work-related courses or to obtain credits for transfer to a four-year college or university. (See "The U.S. Higher Education System.")

Undergraduate S&E Students and Degrees in the United States

Recent Trends in College Enrollment

For almost a decade starting in 1984, undergraduate enrollment in U.S. institutions of higher education showed strong growth, peaking in 1992 with nearly 12.7 million students. Undergraduate enrollment has declined slightly each year since, mainly from the decrease in the college-age cohort of the majority (white) population. The continuing increase in enrollment for all minority groups did not make up for the loss of white enrollment, resulting in an overall decrease.

The trend of increasing enrollment in undergraduate programs by underrepresented minorities has persisted for over a decade and accelerated in the 1990s. Black enrollment increased 3.6 percent annually in the 1990s, reaching 1.3 million in 1995. In the same period, Hispanic enrollment in higher education increased at an even faster rate (7.1 percent annually.) These



national trend data bear watching as some states change affirmative action programs. Undergraduate enrollment of foreign students grew very modestly in the past two decades; in 1995, foreign students still represented only 2 percent of total undergraduate enrollment. (See appendix table 2-11.)

Characteristics of American College Freshmen Planning to Major in S&E

Need for Remedial Work in Mathematics and Science

One indicator of the readiness of American students for college-level S&E courses is their self-reported need for remedial work in mathematics and science. The percentage of freshmen reporting a need for such remedial work has remained high, particularly for women and minorities. In 1995, of those freshmen planning to major in science or engineering, over 16 percent of the males and over 26 percent of the females thought they would need remedial work in math. Among freshman students from underrepresented minority groups planning to major in S&E, over 38 percent reported that they would need remedial work in math. This self-reporting of the need for remedial work differed by planned major. Fewer of the students planning a major in the physical sciences or engineering reported needing remedial math, as compared to those planning a major in the social or biological sciences. (See figure 2-8.) Over 20 percent of minority students planning a major in the biological sciences or engineering thought they would need remedial work in science.

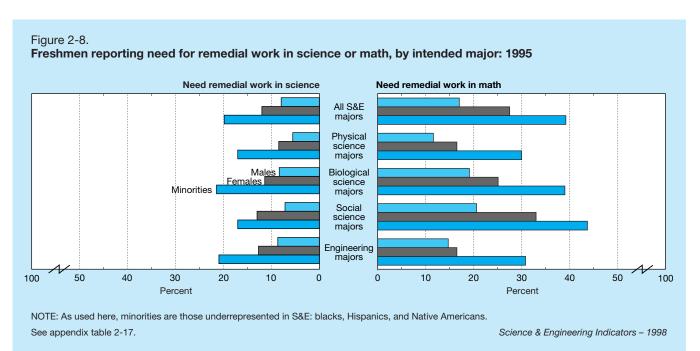
Freshmen Intentions to Major in S&E

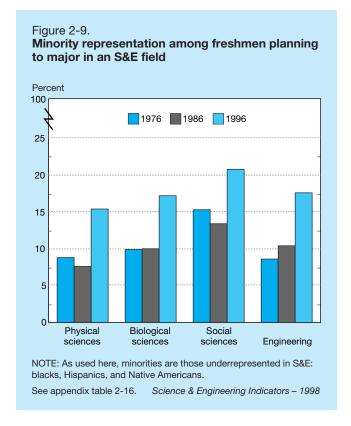
Among the majority (white) population, about one-third of the freshman have traditionally contemplated a major in an S&E field; most of these intend to major in a field of natural or social science, with smaller percentages selecting mathematics, the computer sciences, or engineering. From the late 1970s on, the percentage of freshmen planning an engineering major has remained relatively constant, at around 9 percent. During the same period, mathematics and computer sciences have been the intended majors of around 2 percent of incoming freshmen. Freshmen have fluctuated more in their choice of natural science and social science majors. After a decade-long decline in the selection of natural sciences as a possible major, the trend reversed in 1987, increasing to around 12 percent by 1996. The social sciences have become more attractive majors, but not as popular as the natural sciences. (See appendix table 2-15.)

Planned Majors and Completion Rates by Sex and Race/Ethnicity

Trends in freshman choice of major show differences by sex and race/ethnicity. Asian American students are moving away from a very high concentration of S&E majors—particularly in engineering—and are majoring in a broader range of fields. While still relatively high, the proportion of Asian American males choosing engineering as freshmen declined from 38 percent in 1980 to 23 percent in 1996. For many years, higher proportions of black and Hispanic males have chosen engineering than have white males, and a higher proportion of black females than white females have chosen to major in mathematics and computer sciences. Women of every race/ethnicity, however, show an increase in choice of natural sciences. (See appendix table 2-15.)

An increasing proportion of those students planning to major in S&E fields are from underrepresented minority groups. In 1996, underrepresented minorities accounted for 15 to 21 percent of those planning to major in the following fields: physical sciences, biological sciences, social sciences, and





engineering. In 1976, underrepresented minorities accounted for between 9 and 15 percent of those planning to major in these fields. (See figure 2-9.)

A substantial fall-off occurs between freshmen declaration of intent to study S&E fields and actual completion of S&E degrees (Astin and Astin 1992). This fall-off differs by race, particularly in NS&E fields. There is some fall-off among the majority (white) students: 12 percent intend to major in natural sciences and 9 percent in engineering, but only 8 percent of degrees earned by white students are in the natural sciences and only 5 percent in engineering. A larger fall-off occurs among underrepresented minority groups. Ten percent of black students intend to study a field of natural science, but only 5 percent of degrees earned by blacks are in these fields. Further, 9 percent of black students intend an engineering major, but only 3 percent of undergraduate degrees earned by black students are in engineering. (See appendix tables 2-15 and 2-21.)

Engineering Enrollment

Engineering programs require students to declare their major as freshmen, allowing engineering enrollment to be used as an early indicator of undergraduate degrees. The composition of enrollment can also be used as an indicator of participation rates of women and minorities. Undergraduate engineering enrollment declined from a high of 441,205 students in 1983 to 356,177 students in 1996, representing a 19 percent reduction. The decline was neither smooth nor continuous. Engineering enrollment stabilized for several years (1989 to 1992) before resuming its decline. Part-time student enrollment, which accounts for about 10 percent of overall enrollment, has remained relatively stable during the last decade. The relative steadiness of engineering enrollment in the early 1990s is reflected in the stable number of engineering degrees in the 1993-95 period. (See appendix tables 2-13 and 2-20). However, the decline in overall engineering enrollment from 1993 portends a decline in engineering degrees at the end of the decade and in the year 2000.

While overall undergraduate engineering enrollment has been declining, enrollment of women and minorities has been increasing, particularly in the 1990s. The number of female students enrolled in engineering increased from 61,000 in 1990 to 68,000 in 1996. For underrepresented minorities, the increase was greater, from 41,000 in 1990 to almost 54,000 in 1996. By 1996, female students represented 19 percent of total undergraduate engineering enrollment, and underrepresented minorities represented 15 percent of such enrollment. Concurrently, the number of foreign students enrolled in U.S. undergraduate engineering programs has been decreasing, in response to enhanced capacity in engineering programs abroad. (See figure 2-10 and appendix table 2-14.)

Science and Mathematics Coursetaking

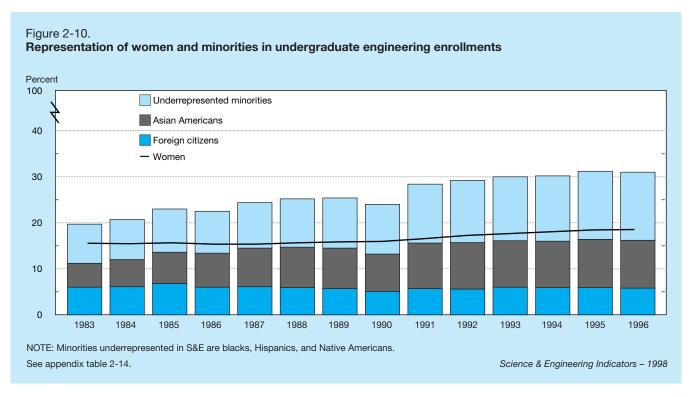
Universities strive to address the academic needs of students in all majors. In addition to S&E, disciplines that require a grounding in mathematics and science include K-12 education, business, and law, among others. With the increasing interplay of science and technology in our society, all citizens benefit from a higher level of technological literacy and an understanding of the methods and processes of science.

Curricular Reform

In the 1990s, many S&E departments have designed or adapted new curricula to broaden the attraction to, and success with, science and engineering courses. For example, several academic institutions have initiated "calculus reform," a movement to align calculus instruction more closely with theories of how students learn; others have created multimedia software modules to enhance visualization for students not majoring in science. A large number of institutions have adopted or designed revitalized curricula or variations of these reforms. (Advisory Committee to NSF/EHR 1996). By 1995, 22 percent of the 372,000 students enrolled in calculus 1 and 2 were using a reform text⁹ along with various other innovations, such as graphing calculators, writing and computer assignments, and group projects (Rung 1997).

⁸Freshman intention data are estimates based on a sample of surveyed students, while degree data are the universe of earned degrees. Therefore, the fall-off in percentages for intentions and actual degrees cannot be measured precisely. Further, the data are not limited to freshmen who actually go on to earn degrees. The comparison does, however, show that there is a fall-off, and that the magnitude is greater for minority students.

⁹A text reflecting the pedagogical principles of the reform calculus movement.



Number of Courses Taken in Science and Mathematics

Recent data from the Longitudinal Study of American Youth (LSAY) reveal some facts about coursetaking behavior in science and mathematics among those who attended twoor four-year colleges and universities. As expected, science, engineering, and mathematics majors report a far higher number of completed mathematics and science courses than non-S&E majors. Over half of the mathematics and engineering majors report five or more courses in mathematics. Over 90 percent of the science majors report five or more courses in science. However, many non-S&E majors are taking mathematics and science courses beyond the general education requirements (in a liberal arts program, typically two mathematics courses and two science courses to graduate). Over half of the education majors who earned a bachelor's degree took three to four mathematics courses, with over 40 percent taking three to four courses in science and 25 percent taking even more. (See appendix tables 2-22 and 2-23.)

Level of Mathematics Courses in Undergraduate Education

Every five years since 1970, the Conference Board of the Mathematical Sciences (CBMS) has conducted a survey of a sample of four-year college and university departments of mathematics and two-year college programs in mathematics. These data are important in estimating overall enrollment trends, as well as in breaking out trends in mathematics courses taken by level of difficulty. Estimates of overall enrollment in courses taken in mathematics departments in four-year institutions declined substantially from the peak years of 1985

and 1990, as fewer undergraduate students majored in mathematics or took calculus or advanced level coursework.

The CBMS data show that mathematical enrollment trends differed by level of institution as well as level of difficulty. Enrollment increased in precalculus courses designed primarily for liberal arts students in four-year colleges and universities, and in remedial mathematics courses in two-year colleges. In 1995, at the community college level, over half (57.8 percent) of the enrollment in mathematics classes was for remedial level courses. This high proportion of remedial mathematics at the community college level has existed since 1985. In 1970, remedial courses in community colleges represented about onethird of all mathematics courses. Within four-year college and university mathematics departments, the estimated enrollment in remedial level courses has remained at about 15 percent of total mathematics enrollment since 1980. The proportion of mathematics enrollment in advanced courses has remained within a range of 6 to 9 percent since 1980, with enrollment in precalculus and calculus each accounting for about 40 percent of total mathematics enrollment). (See text table 2-3.)

Associate Degrees in S&E

At the associate degree level, the number of degrees in engineering technology has fallen precipitously, from 51,000 earned degrees in 1983 to 39,000 degrees in 1995. (See appendix table 2-18.) Between 1994 and 1995, the number of degrees decreased in all fields of S&E. This decline in associate degrees in S&E holds regardless of race/ethnicity. (See appendix table 2-19.) The one exception is Asian American students: in the sciences, their number of earned degrees is increasing slightly.

Text table 2-3. **Estimated enrollment in undergraduate mathematics courses** (Thousands)

	Fall enrollments in math departments of four-year institutions					Fall enrollments in math programs of two-year institutions				
Course level	1970	1980	1985	1990	1995	1970	1980	1985	1990	1995
All math courses	1,188	1,525	1,619	1,619	1,469	555	925	900	1,241	1,384
Remedial	101	242	251	261	222	191	441	482	724	800
Precalculus	538	602	593	592	613	134	180	188	245	295
Calculus	414	590	637	647	538	59	86	97	128	129
Advanced	135	91	138	119	96	0	0	0	0	0
Other						171	218	133	144	160

NOTE: Precalculus-level mathematics courses include algebra and trigonometry courses, as well as courses for nonscience majors, finite mathematics, non-calculus-based business mathematics, and mathematics for prospective elementary school teachers.

SOURCE: D.C. Rung, "A Survey of Four-Year and University Mathematics in Fall 1995: A Hiatus in Both Enrollment and Faculty Increases," *Notices of the AMS*, Vol. 44, No. 8 (September 1997): 923-31.

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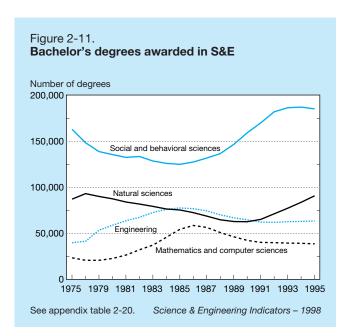
The declining trend in associate degree completions may be partly explained by the changing roles of junior colleges in the United States. Community colleges now go far beyond providing associate of arts degrees. They provide short courses, train in work-related technical skills, and serve as feeder schools to four-year colleges and universities. In contrast to the junior college level in many other countries—such as Japan and France—this level of higher education in the United States provides flexibility, allowing individuals to take courses outside of a degree program, as well as transition to more advanced levels of higher education. Many associate of arts colleges have an agreement with four-year schools to allow transfer of credits. For example, California encourages students to begin their college studies at a local community college, with the understanding that they will be admitted to a state university for their third and fourth years of a bachelor's degree.

Community colleges also pioneered distance learning to reach large numbers of students within their geographic region, and are partnering with universities to provide distance learning with local laboratory work. (See "Distance Learning and Its Impact on S&E Education.")

Bachelor's Degrees in S&E

Except for a brief decline between 1986 and 1989, the number of earned bachelor's degrees in S&E from U.S. institutions has been increasing for over a decade, rising from over 307,000 in 1981 to 378,000 in 1995. Trends in earned S&E degrees in U.S. institutions, however, differ widely by field. In the natural sciences, a long slow decline from 1976 to 1990 ended, shifting to an upturn in such degrees during the 1990s. Natural science degrees increased 7.7 percent annually from 1990 to 1995, with stronger than average growth in the biological and environmental sciences, but only modest (2 percent) growth in the physical sciences. The number of completed math and com-

puter science degrees declined from 1975 to 1979, then climbed steadily reaching almost 59,000 degrees in the peak year of 1986. Attraction to the computer sciences dropped precipitously from 1986 to 1991, followed by slight decreases to 1995. The number of social science degrees awarded, after record growth between 1986 and 1992 (averaging 6 percent annually), has remained stable for the last four years. Engineering degrees, whose numbers also peaked in 1986 following a decade of strong growth—particularly in electrical and mechanical engineering—declined until 1991 and then stabilized. The slight annual growth rate in engineering degrees from 1991 to 1995 is mainly accounted for by the increasing number of degrees in chemical and civil engineering. (See figure 2-11 and appendix table 2-20.)



Distance Learning and Its Impact on S&E Education

Virtually all of the 300 engineering programs in the United States have some form of continuing education with distance learning for a local area; less prevalent but growing is generalized distance learning, with course material on the Internet. Students are increasingly participating in fully developed S&E lessons at home, at the office, in a library carrel, or even at another university. The impetus for distance learning stemmed from the responsibility of community colleges to serve a large number of students within a geographic region, and their need to develop off-site learning centers. In a 1991 survey by the American Association of Community and Junior Colleges, 80 percent of community colleges and 78 percent of universities had plans to provide distance learning by 1994 (Brey 1991).

S&E higher education has benefited from advances in distance learning. In the 1980s, television became an instrumental medium for developing courses and degree programs at the undergraduate and graduate levels. One example is the University of California at Davis Instructional Television program. Classes are broadcast live during the workday, and students usually enroll in one course per quarter. Full-time professional engineers obtain a master's degree in approximately three years and a doctoral degree within five to six years.

Telecommunications and satellite delivery make it possible for students to obtain their degrees almost anywhere in the world. Colleges and universities are using these support technologies to augment their existing distance learning programs—e.g., fax, CD-ROM, e-mail, two-way audio, and teleconferencing. (See text table 2-4.) For example, the National Technological University, a consortium of 47 leading engineering universities, offers 1,200 courses and 13 master's degree programs in science and engineering.

The Internet offers a fundamental advancement in distance learning delivery. The new Internet applications for audio, video, and two-way communication are expected to integrate the previous advancements in distance learn-

ing technologies into a single medium. Schools are beginning to experiment with on-line courses; for example, the University of Phoenix offers on-line courses that present workshops, homework, and even the final exam via the Internet. The Internet's impact on S&E higher education is not clear at this time, but several S&E associations are actively discussing its potential. (For more information, see chapter 8, "IT, Education, and Knowledge Creation.")

Text table 2-4.

Percentage of academic institutions using various technologies in distance learning programs

		-year rsities_	Two-year colleges		
Technology	1991	1994	1991	1994	
Audio					
teleconferencing	30.0	37.0	12.0	25.0	
Audiographics	10.0	22.0	5.0	14.0	
Cable television	22.0	45.0	14.0	35.0	
Compressed					
video/phone	13.0	35.0	3.0	16.0	
ITFS	29.0	46.0	16.0	34.0	
Microwave	25.0	37.0	12.0	27.0	
Satellite (full motion)	33.0	52.0	15.0	30.0	
Satellite (VSAT)	1.0	18.0	0.5	8.0	

NOTES: Audio teleconferencing refers to telephone lines used to create interactivity among several sites. Audiographics is audio teleconferencing in conjunction with computer technologies to include graphics and still images. Compressed video/phone is compressed video via telephone lines. ITFS is instructional television fixed service (broadcast). Satellite (full motion) is full motion analog video transmission. Satellite (VSAT) is very small aperture terminals, interactive digital video network. 1994 data represent projected usage.

SOURCE: Ron Brey, "U.S. Postsecondary Distance Learning Programs in the 1990s: A Decade of Growth," a research project of the Instructional Telecommunications Consortium/American Association of Community and Junior Colleges (Washington, DC: American Association of Community and Junior Colleges, 1991).

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Bachelor's Degrees by Sex

These recent trends in earned degrees for S&E fields show a similar pattern for both males and females, with a few exceptions in the social sciences and engineering. After 1993, degrees earned by males decreased slightly in the social sciences, while females maintained their high number of degrees in these fields. In engineering, females increased their earned degrees in the 1990s, particularly in chemical and civil engineering. In the same period, degrees in engineering earned by males declined slightly. (See figure 2-12.)

Over the past two decades, the proportion of S&E degrees earned by females has increased considerably, particu-

larly in the natural sciences and engineering. In 1975, females earned about one-quarter of the degrees in the natural sciences and 2 percent of those in engineering. By 1995, females earned 59 percent of social science degrees, 47 percent of natural science degrees, 35 percent of mathematics and computer science degrees, and 17 percent of the engineering degrees. (See appendix table 2-20.)

Bachelor's Degrees by Race/Ethnicity/Citizenship

Trends in S&E bachelor's degrees also differ by race/ ethnicity, with white students earning fewer degrees in 1995 than in earlier years, and minority groups continuing their growth in earned degrees in these fields. The number of degrees earned by white students is slowly decreasing in all fields except the natural sciences.

In contrast, the number of degrees earned by underrepresented minorities in the United States—blacks, Hispanics, and Native Americans—is increasing slightly in NS&E fields and very rapidly in the social sciences. (See "S&E Human Capital Development: Continued Unevenness Across Demographic Groups.") In addition, the number of degrees earned by Asian Americans is increasing sharply in the natural and social sciences. (See appendix table 2-21.)

Foreign students have increased their earned degrees in the social sciences, but since 1981 have sharply decreased their degrees in engineering from U.S. institutions, as discussed in more detail below. The capacity to educate engineering students at the undergraduate level has increased dramatically in other world regions, and fewer foreign students are using U.S. universities for engineering education.

Participation Rates by Sex and Race/Ethnicity

The United States is one of the leaders in the world in providing access to higher education and ranks high among the major industrialized countries in the proportion of its population with an S&E background. These national statistics, however, do not apply to all fields or to all minority groups. In 1995, for the country as a whole, over 32 percent of the college-age population had completed a bachelor's degree in some field, and over 5 percent had earned a bachelor's degree in an NS&E field. But in that same year, only about 15 percent of black and Hispanic youth earned a bachelor's degree, and only about 2 percent of black and Hispanic youth earned a bachelor's degree in an NS&E field. In contrast, Asian

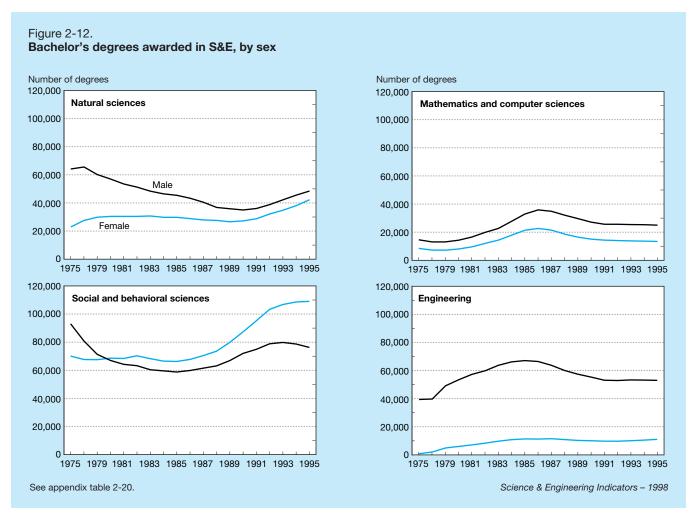
S&E Human Capital Development: Continued Unevenness Across Demographic Groups

Beginning in the early 1980s, increasing numbers of women and minorities entered U.S. higher education. For a decade, the broadened entry of these groups fueled the expansion of enrollment in U.S. higher education and helped offset the trend of a declining U.S. college-age cohort. However, this broader access and increased enrollment in higher education did not concurrently result in larger numbers of S&E degree completions for women and minorities in all S&E fields at all levels. The pattern of participation is stronger in overall enrollment than in completed S&E degrees, stronger for females than for males in all underrepresented minority groups, stronger at the undergraduate than graduate level, and stronger in the natural and social sciences than in computer sciences and engineering.

Women. In the last decade, women achieved a higher rate of growth in undergraduate enrollment than men, particularly women in minority populations. Women now constitute 56 percent of undergraduate enrollment and an even higher percentage among minority populations. Women of every racial/ethnic group are increasingly choosing majors in the natural sciences and social sciences. At the bachelor's level, women now earn over half of the social science degrees and almost half of natural science degrees. However, women are less fully represented at the graduate level; in 1995, they accounted for 38 percent of total graduate enrollment. Women earned the majority of master's degrees in the social sciences and 41 percent of the master's degrees in the natural sciences. Women are least fully represented at the doctoral level. While women earn half of the doctoral degrees in the social sciences and 32 percent of the degrees in the natural sciences, they earn only 20 percent of the doctoral degrees in mathematics and computer sciences and less than 12 percent of doctoral engineering degrees.

Underrepresented minorities. The trend of increasing enrollment in undergraduate programs by underrepresented minorities has persisted for over a decade and accelerated in the 1990s, particularly for Hispanic populations. While minority groups indicate high aspirations to study S&E (as measured by freshman intentions), a substantial falloff occurs between freshman declaration of intent and actual degree completion. This fall-off is greater for underrepresented minorities than for the majority population. Women and minority students are more likely to report a need for remedial work in mathematics and science than the majority male population. (Chapter 1 further discusses the large gap between minority students and the overall student population in number of science and mathematics courses taken.) There has been modest progress in minority participation in S&E degree completions. From 1975 to 1995, S&E bachelor's degrees earned by minorities increased from 6 to 8 percent of total such degrees. (Underrepresented minorities are around 28 percent of the college-age cohort.) Only about 2 percent of the 24-yearolds in underrepresented minority populations hold a bachelor's degree in NS&E—less than half the rate of the majority white population.

Progress for underrepresented minorities in S&E graduate enrollment has been very modest. In 1975, they accounted for 3.7 percent of S&E graduate enrollment; by 1995, they accounted for 5.0 percent. Minority students are underrepresented in S&E graduate degrees. They earn 7 percent of the master's degrees in S&E fields and less than 5 percent of the doctoral degrees. Women in these minority groups earn the majority of these degrees. (See NSF 1996f for disaggregated degree data by sex within each racial/ethnic group.)



Americans, representing only 4 percent of the U.S. population, have considerably higher than average participation rates: almost 40 percent obtained a bachelor's degree, and over 12 percent earned such a degree in NS&E.

Recent participation rates do show some progress toward more diversity in higher education in general and in S&E fields, compared with 1980 and 1990 data. (See text table 2-5.) Low participation rates for blacks and Hispanics changed little throughout the 1980s, although they improved considerably in the 1990s, particularly in the social sciences. In 1995, 3.8 percent of the U.S. female population earned an NS&E degree, compared to 2.1 percent in 1980.

U.S. Students Studying Abroad

A recent study highlights the core elements of an international education that will be important for American youth preparing to work in the global economy of the 21st century (IIE 1997). Referred to as "transnational competence," this education involves a combination of cultural and technical skills, including:

- knowledge of commercial, technical, and cultural developments in a variety of locales;
- ♦ understanding of local customs and negotiating strategies;

- facility with English and at least one other major language;
- ♦ facility with computers; and
- skills in technology and awareness of their different cultural contexts.

The United States has traditionally been weak in providing foreign language instruction. More recently, however, universities are improving undergraduate education by attempting to provide meaningful international experience as an integral part of coursework. (See "International Engineering Programs in the United States.") While there are no national data on the short-term visits conducted under such enhanced undergraduate curricula, the number of courses taken for credit overseas have increased, including engineering courses. (See text table 2-6.)

Graduate S&E Students and Degrees in the United States

Trends in Graduate Enrollment

Enrollment in U.S. graduate S&E programs grew for almost 20 years, reached a peak of almost 440,000 students in 1993, and then began to shrink. From 1975 to 1993, the total number of students in graduate programs increased steadily

Text table 2-5.

Percentage of 24-year-olds earning first university degrees in S&E, by sex and race/ethnicity

Sex and race/ethnicity	Total 24-year-old population	Total first university degrees	Natural science degrees	Social science degrees	Engineering degrees	With first university degree	With NS&E degree	With social science degree
				1980				
Total	4,263,800	940,251	110,253	138,682	58,810	22.1	4.0	3.2
Male	2,072,207	477,750	71,346	67,009	52,858	23.1	6.0	3.2
Female	2,191,593	462,501	38,305	68,623	5,952	21.1	2.1	3.1
White	3,457,800	807,509	100,704	151,839	60,856	23.4	4.7	4.4
Asian	64,000	48,908	3,467	3,039	3,866	29.5	10.2	4.8
Black	545,000	60,779	4,032	16,388	2,449	11.1	1.4	3.0
Hispanic	317,200	30,167	3,646	7,641	1,820	10.5	1.7	2.4
Native American	29,800	3,693	337	898	195	12.1	1.8	3.0
				1995				
Total	3,576,400	1,062,151	123,647	207,032	63,330	32.8	5.4	5.8
Male	1,817,400	495,867	66,540	76,256	52,421	29.2	6.9	4.2
Female	1,759,000	566,284	55,925	108,056	10,850	36.6	3.8	6.2
White	2,863,400	856,686	84,675	156,472	43,726	31.2	4.8	5.5
Asian	148,600	30,027	12,007	10,336	6,785	39.9	12.7	7.0
Black	527,600	59,301	8,021	16,662	2,845	16.2	2.1	3.2
Hispanic	466,800	43,894	6,119	12,420	3,651	14.2	2.1	2.7
Native American	37,000	4,212	676	1,230	221	17.4	2.4	3.3

NS&E = natural sciences and engineering

NOTE: Population data are for U.S. residents only and exclude members of the armed forces living abroad.

SOURCE: U.S. Bureau of the Census, Current Population Reports, series P-25, Nos. 519 and 917 (Washington, DC)

See appendix tables 2-20 and 2-21.

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Text table 2-6. **U.S. students studying abroad, by field of study**

			Percentage studying						
	Total students studying abroad	All S&E fields	Physical sciences	Math & computer sciences	Agriculture	Engineering	Social sciences & humanities		
1987/88	62,341	19.9	2.5	1.2	0.8	1.4	14.0		
1989/90	70,727	22.8	3.7	0.8	0.4	1.3	16.6		
1993/94	76,302	46.7	5.3	1.1	0.9	2.3	37.1		
1994/95	84,403	47.5	6.8	1.2	0.7	2.2	36.6		

SOURCE: Institute of International Education, Open Doors, 1995-1996: Report on International Education Exchange (New York: 1996)

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at an average annual rate of 2 percent. Subsequent declining enrollment has averaged 1 percent annually. Fewer students enrolling in engineering, mathematics, and the computer sciences account for most of this decline. Engineering, mathematics, and computer science enrollment grew at a rate of almost 4 percent annually from 1975 to 1992, but declined 3 percent annually from 1992 to 1995. While a slightly increasing number of students continues to enroll in the social and natural sciences, the annual rate of increase in these fields slowed after 1992. Trends differ when examining subfields: a look at the natural sciences shows that graduate enrollment in the physical sciences has decreased, while enrollment in the biological sciences has increased (NSF 1996e).

Enrollment by Sex, Race/Ethnicity, and Citizenship

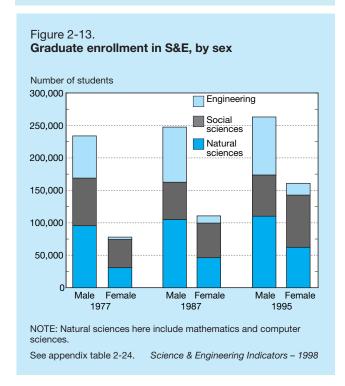
While there are fewer graduate students in science and engineering, U.S. students today are a more diverse group than in the past. In 1977, women represented only one-quarter of S&E graduate enrollment; by 1995, they accounted for 38 percent of enrollment. (See figure 2-13.) While women and minorities continued a decade-long trend of increased enrollment in graduate S&E programs in 1993, enrollment figures for foreign students and U.S. white males began a downward trend. (See figure 2-14.)

In 1992, foreign graduate students reversed their decadelong trend of increased S&E enrollment in U.S. institutions.

International Engineering Programs in the United States

International engineering programs (IEPs) allow U.S. students to gain valuable experience in an international setting. Traditional engineering curricula have been too tight and structured to allow engineering students to study abroad. IEPs, however, are customized to permit such study. A University of Cincinnati survey of universities with IEPs listed on the World Wide Web shows study abroad and work abroad components integrated into the engineering programs of about 25 major U.S. universities. A well-structured IEP gives students an opportunity to examine engineering in a foreign culture.

To promote the creation of IEPs, several universities in the United States and abroad are affiliated with the International Engineering Consortium. The consortium conducts a broad range of university-industry cooperative programs and continuing education programs. Members of academia and industry meet to discuss leading-edge technology, issues vital to the information age, and the nature of today's global marketplace. (For more information, see <<ht>http://www.iec.org>>.)



They decreased their enrollment each year since then. From 1983 to 1992, the number of foreign graduate students increased over 5 percent annually. From 1992 to 1995, their numbers decreased more than 3 percent annually. (See appendix table 2-25.)

The field of engineering illustrates both decreasing enrollment and increasing diversity. The number of students enrolled in graduate programs in engineering declined from approximately 118,000 in 1992 to less than 108,000 in 1995. But 1995 enrollment included almost 1,000 more women and 1,000 more underrepresented minorities than in 1992. One factor in the increasing enrollment of minorities in graduate S&E programs may be changing demographics—the higher growth rate in the minority population relative to the white population. The approximately 10,000-person decrease in engineering students from 1992 to 1995 was primarily due to declining numbers of foreign students and U.S. white males. In 1995, the number of foreign students represented about one-third of U.S. graduate enrollment in engineering, down from a peak of 34 percent in 1992. (See figure 2-15 for the declining enrollment of foreign students in graduate engineering.)

The recent decline in foreign students is likely influenced by the increasing educational opportunities in other countries. The growing capacity for S&E graduate education in Asian countries is shown not only in the expansion of higher education institutions in Asia (see "Growth in Institutions of Higher Education in Asia"), but also in the high rate of growth in earned doctoral degrees within Asian universities. (See appendix table 2-26.)

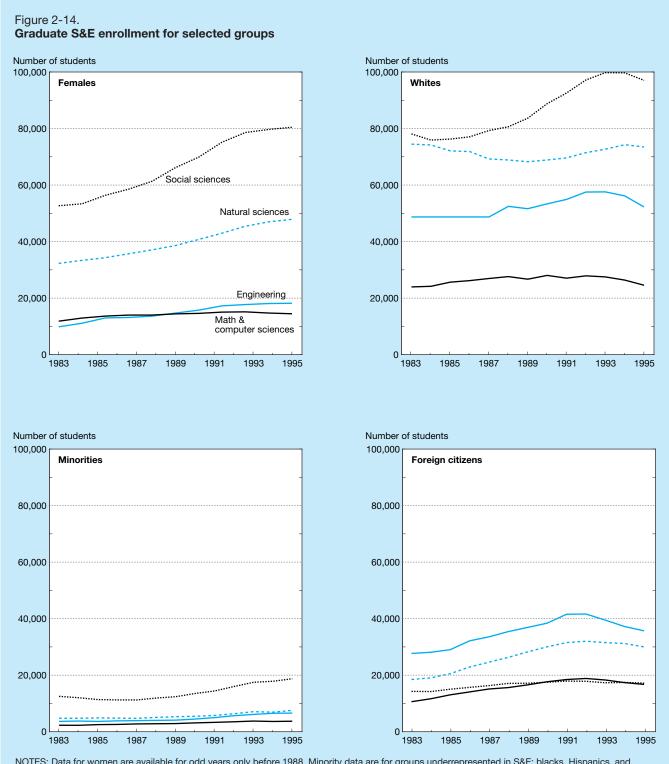
Foreign Students in All Levels of U.S. Higher Education

The majority of foreign students in the United States come from a small group of countries. Twelve leading countries of origin account for over 60 percent of the approximately 450,000 foreign students enrolled in U.S. higher education. Students from Asian countries—the most significant region of origin of foreign students in U.S. institutions—come to study at both the graduate and undergraduate levels. (See text table 2-7.) Students from China and India come to study mainly at the graduate level and overwhelmingly in NS&E fields. In contrast, students from Japan enroll mainly at the undergraduate level for non-S&E fields such as business administration. Enrollments of students from South Korea and Taiwan are more equally divided among graduate and undergraduate programs. Undergraduate students from South Korea and Taiwan in U.S. institutions study mainly non-S&E fields, while the majority of South Korean and Taiwanese graduate students enter S&E fields. (See appendix table 2-34.)

Master's Degrees

Over the past two decades, the overall trends in science and engineering degrees at the master's level show an increase in the number of earned degrees throughout the 1980s, with even stronger growth in the 1990s. The recent growth is mainly accounted for by the rising numbers of earned degrees in the social sciences and engineering, with relatively stable numbers in the natural sciences, mathematics, and computer sciences.

Examining trends within each field highlights the variations among different time periods of the past 20 years. In natural science fields, after a slight downward trend in the



NOTES: Data for women are available for odd years only before 1988. Minority data are for groups underrepresented in S&E: blacks, Hispanics, and Native Americans.

See appendix tables 2-24 and 2-25.

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Text table 2-7. Foreign student enrollment in U.S. higher education, by region of origin: 1995/96

Africa 20,844 Asia 259,893 Europe 67,358	Total, all regions	453,635
	Africa	20,844
Europe	Asia	259,893
	Europe	67,358
Latin America	Latin America	47,253
Middle East	Middle East	30,563
North America	North America	23,644
Oceania	Oceania	4,202

SOURCE: Institute of International Education, *Open Doors 1995-96:* Report on International Educational Exchange (New York: 1996).

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1980s, the number of graduate students successfully completing master's degrees increased in the 1990s. In mathematics and the computer sciences, the very strong growth rate in earned master's degrees in the 1980s (almost 8 percent annually) shifted to a more modest growth rate in the 1990s, about 2 percent. The slight downward trend in earned master's degrees in the social sciences turned around in 1989, with sharply increasing numbers of social science degrees since then. The rapid growth in engineering master's degrees after 1980 leveled off in 1989-91, increased from 1991 to 1994, and then again leveled off in 1994-95. (See appendix table 2-27.)

Master's Degrees by Sex

Over the 20-year period 1975 to 1995, males accounted for the strong growth in master's degrees in engineering, mathematics, and the computer sciences. Females were primarily responsible for the strong growth in social sciences; they also obtained a larger share of degrees in the natural sciences. However, the proportion of master's degrees earned by females increased considerably in the last two decades—not only in the natural sciences, but in engineering as well. In 1975, females earned 21.1 percent of the natural science degrees at the master's level and 2.5 percent of the engineering degrees. By 1995, females accounted for 41.0 percent of natural science degrees and 16.2 percent of engineering degrees. (See appendix table 2-27.)

Master's Degrees by Race/Ethnicity

In the 1990s, minority groups in the United States earned, in most cases, increasing numbers as well as increasing shares of master's degrees in S&E fields. The number of S&E degrees earned by Asian Americans consistently increased, especially in engineering, mathematics, and the computer sciences. The number of S&E master's degrees obtained by blacks grew modestly in most fields, with strong growth in the social sciences. Despite gains in individual S&E fields, the overall share of master's degrees in S&E earned by black students declined slightly from 1977 to 1995. Hispanics earned a modestly increasing number—and proportion—of degrees in the social sciences, as well as in engineering. White stu-

Text table 2-8.

Percentage of S&E master's degrees earned by minorities and foreign citizens

Race/ethnicity and citizenship	Natural sciences	Social sciences	Engi- neering	
	1977			
Asian	2.6	1.7	4.5	
Black	2.4	6.2	1.5	
Hispanic	1.5	3.0	1.6	
Native American	0.3	0.3	0.1	
Foreign citizen	15.6	7.0	21.8	
	1995			
Asian	7.8	2.7	9.0	
Black	3.0	5.9	2.3	
Hispanic	2.3	4.0	2.5	
Native American	0.3	0.6	0.2	
Foreign citizen	28.5	10.8	33.9	

NOTE: Natural sciences here include math and computer sciences.

See appendix table 2-28. Science & Engineering Indicators – 1998

dents showed modest growth in NS&E degrees earned in the 1990s, and strong growth in social science. Notwithstanding these gains, the share of master's degrees earned by white students in all fields declined during the 1977-95 period. (See text table 2-8 and appendix table 2-28.)

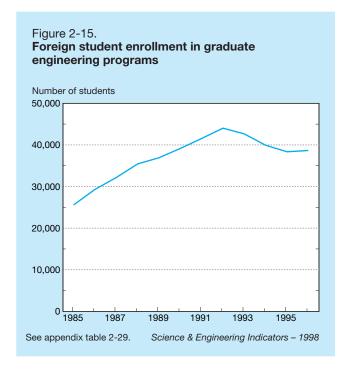
Master's Degrees by Citizenship

Analysis of master's degrees by citizenship shows a continuation of the trend toward a larger proportion of degrees going to foreign students in engineering, mathematics, and the computer sciences. In 1975, foreign students earned 21.8 percent of the engineering degrees and 11.3 percent of the math and computer science degrees. By 1995, foreign representation at the master's level was 33.9 percent in engineering and 34.7 percent in math and computer sciences. (See appendix table 2-28.)

However, the rate of growth of overall S&E master's degrees obtained by foreign students slowed somewhat in the 1993-95 period, primarily because of the leveling off in their earned degrees in mathematics and computer sciences. There is as yet no evidence of declining numbers of engineering degrees awarded to foreign students, even though foreign graduate enrollment in engineering decreased from 1993 to 1995 and leveled off in 1996. (See figure 2-15.)

Doctoral Degrees

From 1975 to 1985, the number of S&E doctoral degrees granted in the United States was relatively stable. After 1985, however, the number of such degrees grew, reaching over 26,000 by 1995. (See figure 2-16.) Large increases in the number of earned degrees occurred mainly in engineering, mathematics, and computer sciences. The number of degrees in these fields nearly doubled from 1985 to 1995. Natural science fields—



particularly the biological sciences—also contributed to the rising number of degrees, with a 30 percent increase.

Doctoral Degrees by Sex

Male doctoral degree recipients accounted for much of the growth in engineering, mathematics, and computer sciences, while female doctoral recipients were largely responsible for the increasing number of natural science degrees.

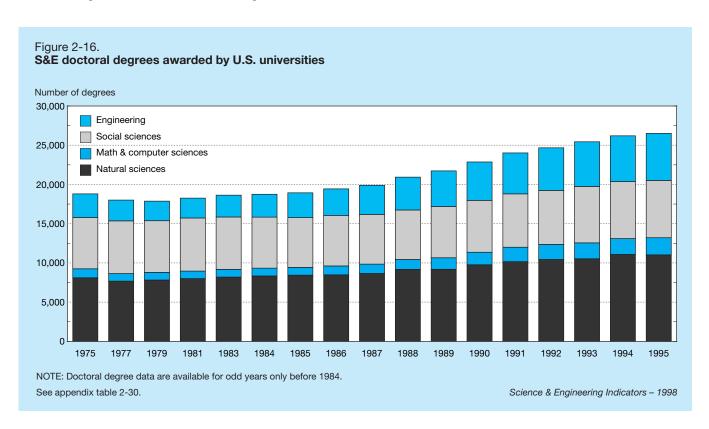
Within the past two decades, the share of S&E doctoral degrees earned by women doubled from 15.6 percent in 1975 to 31.2 percent in 1995. The proportion has differed by field. By 1995, females earned almost half of the doctoral degrees in the social sciences and 38 percent in the biological sciences. (See appendix table 2-30.) Growth in the proportion of degrees awarded to women was greatest in engineering subfields. By 1995, women earned almost 12 percent of all engineering doctorates, and 15 to 16 percent of doctoral degrees in chemical and materials engineering.

Doctoral Degrees by Race/Ethnicity

Underrepresented minorities within U.S. universities received almost 5 percent of all S&E doctorates awarded in 1995, up slightly from 3 percent in 1977. As a group, these minorities accounted for 8 percent of earned degrees in the social sciences, 4 percent in the natural sciences, 3 percent in engineering, and 2 percent in mathematics and the computer sciences. For black Ph.D. recipients, the largest numerical increases in the past decade have been in the biological and social sciences. The largest percentage increases have been in the biological sciences and engineering. (See appendix table 2-31 and NSF 1996d.)

Foreign Doctoral Students in the United States

In the past decade, foreign students have accounted for the large growth in S&E doctoral awards in U.S. universities. The number of foreign doctoral recipients in U.S. universities doubled in S&E fields from over 5,000 in 1986 to over 10,000 in 1995. This doubling translates to an 8.2 percent average annual increase. In contrast, the rate of increase in doctoral de-



grees to U.S. citizens averaged only 1.9 percent annually.

Within NS&E fields, the proportion of doctoral degrees earned in U.S. universities by foreign citizens climbed from 31 percent in 1986 to 47 percent in 1994; it has since begun to level off. (See figure 2-17.) Foreign students from China, India, South Korea, and Taiwan have played a central role in this growth. In 1995, foreign doctoral recipients from these four Asian economies accounted for 59 percent of all S&E doctorates earned by foreign students (NSF 1996d). In 1995, the share of NS&E degrees earned by foreign students decreased slightly to 46 percent, mainly due to a decline in doctoral degrees earned by South Korean and Taiwanese students. Both of these economies (which are major contributors of foreign graduate students in the United States) have increased their internal capacity for graduate education in science and engineering, evidenced by the increasing number of in-country doctoral degrees in these fields. (See appendix table 2-36.)

Even as Asian students entered U.S. graduate programs in record numbers, Asian universities were expanding their own doctoral degree programs in S&E fields. In fact, the two phenomena are related. The desire to increase their within-country capacity to educate their students through the doctoral level required sending students abroad as a way of preparing more S&E faculty for expanded graduate programs within Asian universities. In the period 1988-94, the Asian effort to receive doctoral training in U.S. universities was particularly intense, as evidenced by an increase from 2,872 earned degrees in 1989 to 6,229 in 1994. The annual rate of growth in earned S&E doctoral degrees during this period was over 17 percent. This rate of growth has slowed considerably in the last few years, however.

Students from Asian countries are becoming less dependent on U.S. universities for their doctoral training. After 1993,

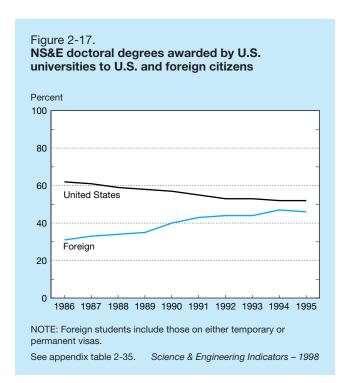


Figure 2-18.

S&E doctoral degrees awarded to Asian students by Asian and U.S. universities

Number of degrees
20,000

15,000

Asian universities

5,000

U.S. universities

V.S. universities

NOTE: Data for U.S. universities are not available before 1983.

See appendix table 2-36. Science & Engineering Indicators – 1998

the annual rate of increase in the number of earned S&E doctoral degrees within Asian universities greatly exceeded the growth in degrees earned by Asian foreign students within U.S. universities. (See figure 2-18.) While Ph.D. production in S&E fields is growing at a faster rate in Asian countries than in the United States, it should be noted that the base is lower. In 1995, total doctoral degrees in S&E earned in six Asian countries numbered 15,700. In that same year, U.S. universities produced over 26,000 doctoral S&E degrees; over 6,000 of these degrees were earned by foreign students from Asia. (NSF 1996e). In 1995, the number of doctoral NS&E degrees earned from universities within four Asian economies exceeded the number of such degrees earned by Asian foreign students within U.S. universities. Only for Taiwan do U.S.-earned NS&E doctoral degrees outnumber those earned within Taiwanese universities. However, in engineering, China, India, and South Korea still obtain more doctoral degrees from U.S. universities than from their home country universities. (See text table 2-9.)

Besides providing doctoral training to foreign students from Asia, U.S. higher education is also linked to expansion of Asian capacity in S&E education through institution building. Leading research universities in the United States are advising developing countries in their design of higher education in science and engineering. For example, the Massachusetts Institute of Technology has accepted an agreement to create a scientific research university in Malaysia (Sales 1997).

Stay Rates of Foreign Doctoral Recipients in the United States

Until 1992, around half of the foreign students who earned doctoral degrees in S&E in U.S. universities planned to locate in the United States after completing their degrees. A

Text table 2-9.

NS&E doctoral degrees awarded to Asian students by Asian and U.S. universities: 1995

	Within country Ph.D. in:		U.S. un Ph.D	,
Student place of origin	Natural sciences	Engi- neering	Natural sciences	Engi- neering
Five-country				
total	8,576	6,327	2,335	3,268
China	1,373	1,659	773	1,802
India	4,077	348	572	499
Japan	2,143	3,009	30	51
South Korea	750	938	344	414
Taiwan	233	373	616	502

NS&E = natural sciences and engineering

SOURCES: China—National Research Center for Science and Technology for Development, unpublished tabulations, 1996; India—Department of Science and Technology, Research and Development Statistics 1994-95 (New Delhi: 1996); Japan—Monbusho, Monbusho Survey of Education (Tokyo: annual series); South Korea—Ministry of Education. Statistical Yearbook of Education (Seoul: 1996); Taiwan—Educational Statistics of the Republic of China (Taipei: 1996); United States—National Science Foundation, Science Resources Studies Division, Selected Data on Science and Engineering Doctorate Awards: 1995, NSF 96-303 (Arlington, VA: 1996)

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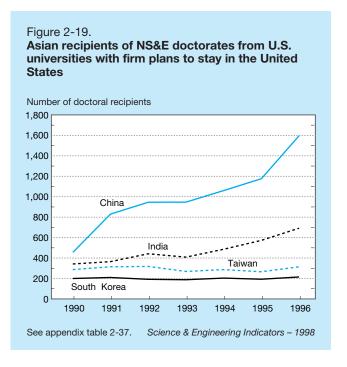
significantly smaller proportion (one-third) received firm offers to remain in the United States for academic or industrial employment. The proportion of foreign doctoral recipients who plan to locate in the United States and accept firm offers differs considerably by country and region. Students from Asian countries, who are the most numerous, are the most likely to stay in the United States. In contrast, of the less numerous students from North and South American countries, fewer plan to locate in the United States.

For the period 1992-96, the percentages of foreign S&E doctoral recipients planning to remain in the United States increased: over 68 percent planned to locate in the United States, and nearly 44 percent had firm offers to do so. This recent increase in stay rates, which may be temporary, is mainly accounted for by the sharp increase in the percentage of Chinese students with firm plans to stay in the United States. In 1990, 42 percent of over 1,000 Chinese S&E doctoral recipients in U.S. universities had firm plans to stay. By 1996, 57 percent of the nearly 3,000 Chinese S&E doctoral recipients from U.S. universities had firm plans to remain in the United States. The underlying cause for this shift is the large number of Chinese students granted permanent residence status in the United States in 1992 following China's response to student demonstrations. In 1996, students from selected countries in Europe also increased their stay rates after completing advanced S&E degrees from a U.S. university, but their numbers are small in comparison to Asian countries: 61 from the United Kingdom and 75 from Germany. (See appendix table 2-37.)

Among Asian countries, China and India apparently have a limited capacity to provide high-level employment to large numbers of returning recipients of doctoral degrees in science and engineering. In 1996, 57 and 59 percent, respectively, of the U.S. S&E doctoral recipients from these countries choose to accept employment in the United States. (See appendix table 2-37.) In contrast, only 24 percent of 1996 doctoral recipients from South Korea and 28 percent from Taiwan accepted employment offers in the United States. The trend in the 1990s has been for fewer doctoral recipients from these economies to remain in the United States because of within-country employment opportunities; this is particularly true of South Korean engineering doctoral recipients. (See figure 2-19.)

To a large extent, the definite plans of foreign S&E doctoral recipients to remain in the United States revolve around postdoctoral study rather than employment. Between 1988 and 1995, individuals from the five economies with the largest numbers of foreign doctoral recipients cited further study as their main reason to stay in the United States (58 percent), followed by employment in R&D (27 percent), teaching (7 percent) and other professional employment (8 percent). (See text table 2-10.)

A recent study of foreign doctoral recipients working and earning wages in the United States (Finn, 1997) shows that about 47 percent of the foreign students who earned S&E doctorates in 1990 and 1991 were working in the United States in 1995. The percentages are higher in physical sciences and engineering, and lower in the life sciences and social sciences. (See chapter 3, "Stay Rates of Foreign Recipients of U.S. Ph.Ds.") These stay rates differ more by country of origin than by discipline, however. The majority of the 1990-91 foreign S&E doctoral recipients from India (79 percent) and China (88 percent) were still working in the United States in



Text table 2-10.

Foreign recipients of S&E doctorates from U.S. universities with definite plans to remain in the United States: 1988-95

				F	Primary activity	
Place of origin	Total S&E doctoral recipients	Total definitely planning to remain	Post- doctoral study	R&D	Teaching	Other Professional
Canada	2,111	897	449	235	98	115
China	13,598	6,238	4,120	1,342	295	486
India	6,585	3,542	1,535	1,316	315	375
South Korea	7,872	1,765	1,324	266	121	55
Taiwan	8,778	2,411	1,197	863	145	208

SOURCE: National Science Foundation, Science Resources Studies Division, Statistical Profile of Foreign Doctoral Recipients, by Major Country of Origin (Arlington, VA: 1998, forthcoming).

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1995. In contrast, only 10 percent of South Koreans who completed engineering doctorates from U.S. universities in 1990-91 were working in the United States in 1995. (See appendix table 2-38.)

The same study looked at foreign doctoral recipients from 1970 to 1972. Finn estimated that 47 percent were working in the United States in 1995, and that the stay rate for that group had fluctuated around 50 percent during the 15 years leading up to 1995. There is no evidence of significant net return migration of these scientists and engineers after 10 or 20 years of work experience in the United States. This does not mean that there is no significant return migration; in fact, such migration is known to occur. (See "Reverse Flow of Scientists and Engineers to Asia" later in this chapter.) However, the fairly constant stay rates indicate that any tendency of the 1970-72 cohorts to leave the United States after gaining work experience here has been largely offset by others from the same cohorts returning to the United States after going abroad.

Postdoctoral Appointments¹⁰

Postdoctoral research positions in science and engineering in U.S. universities increased 5 percent annually from the mid-1980s, and continued this rate of growth until 1994. Most of the growth in the number of postdoctoral appointments, which reached almost 26,000 in 1994, can be accounted for by the expansion of research performed by universities and the concomitant increase in earned doctoral degrees. From 1985 to 1994, funding of research performed by U.S. universities increased at almost \$1 billion a year in constant dollars, from a base of \$10 billion. (See chapter 4.) However, in 1995 the rate of increase in the availability of postdoctoral appoint-

ments slowed considerably, dropping to only 1 percent. In that year, R&D expenditures for university-performed research also stabilized.

During the period of rapid growth in S&E postdoctoral appointments, foreign students earned an increasing proportion both of doctoral degrees and of subsequent postdoctoral appointments. From 1990 to 1994, U.S. universities provided slightly more than half of their postdoctoral appointments to non-U.S. citizens. During this period, the growth rate of domestic postdoctoral appointments was about 4 percent. However, like the recent decline of foreign graduate enrollments in science and engineering in U.S. universities since 1993, there has been a slightly smaller proportion of foreign postdoctoral appointments and a slightly increasing number of appointments to U.S. citizens, particularly in the sciences. Foreign postdoctoral recipients still receive the majority of such research positions within U.S. universities in engineering. (See appendix table 2-39 and chapter 3, "Postdoctorate Appointments.")

Mobility is a characteristic of postdoctoral researchers throughout the world, however. Foreign scientists and engineers represent approximately 50 percent of the postdoctoral pool in the United States; the United Kingdom and France have a high percentage of foreign postdoctorates as well, although the number of postdoctoral positions in these countries is much smaller. In addition, Japan is attempting to improve the quality of its basic research at universities by offering more postdoctoral fellowships for both Japanese and foreign doctoral scientists and engineers.

Foreign Faculty in U.S. Higher Education

One indicator of mobility of S&E personnel in the world is the proportion of foreign-born faculty in U.S. higher education. The United States has been a magnet for trained scientists and engineers because of a well-developed economy able to absorb high-level personnel. (See chapter 3, "Foreign-Born Scientists and Engineers in the United States.") This section reviews data on those S&E faculty members in four-

¹⁰ The data reported here are from the National Science Foundation's Survey of Graduate Students and Postdoctorates in Science and Engineering (NSF 1997b), and include university postdoctoral appointments only; these account for about 70 percent of U.S. postdoctoral appointments. The remaining 30 percent of such appointments are made by the National Institutes of Health, federal research laboratories, and private companies. Data on such appointments are not captured by this survey.

year colleges and universities who were born in another world region and whose primary job is teaching in an S&E field.¹¹

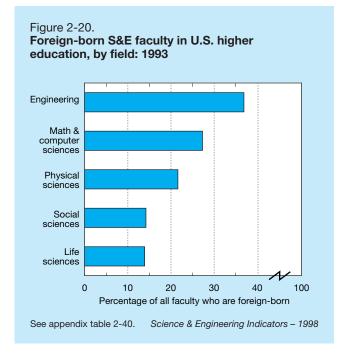
The U.S. university system has been able to employ considerable numbers of foreign-born scientists and engineers. In 1993, foreign-born faculty in U.S. higher education represented 37 percent of the engineering professors and 27 percent of the mathematics and computer science teachers. (See figure 2-20.) These faculty are mainly from Asia and Europe, with the largest numbers coming from India, China, the United Kingdom, Taiwan, Canada, and South Korea. (See text table 2-11.)

Reverse Flow of Scientists and Engineers to Asia

In the past decade, Asian foreign students—mainly from China, India, South Korea, and Taiwan—have earned nearly 45,000 doctoral degrees in S&E within U.S. universities. (See appendix table 2-43 and text table 2-12.) Compared to these major Asian countries of origin, the number of students from Singapore and Japan earning doctoral degrees in the United States is relatively small. Japanese industries often finance advanced training of their employees in U.S. universities for one to two years, but relatively few remain long enough to complete a doctoral program (NSF 1997c).

As mentioned above, a considerable number of doctoral recipients from Asian countries have received firm offers to remain in the United States. These Asian scientists and engineers have contributed significantly to the U.S. university system. In 1993, Asian-born faculty in U.S. higher education represented 19.7 percent of the faculty in engineering, 9.6 percent in the physical sciences, and 12.5 percent in mathematics and computer sciences. (See appendix table 2-40.) They have also contributed to U.S. industry as R&D personnel and by starting new companies. Immigrant scientists and engineers make up 28 percent of the S&E labor force in the United States (NSF 1995b). Many Asian scientists working in the United States participate in communication networks with home-country scientists. The dramatic growth in Asian economies has provided U.S.-based Asian scientists and engineers with more opportunities for cooperative research and consulting (Choi 1995).

The decision of foreign doctoral recipients to remain and work in the United States or to return home relates to job opportunities in their home country. Some dynamic Asian economies are gaining the capacity to absorb high-level S&E personnel. For example, foreign doctoral recipients from Taiwan, South Korea, and Hong Kong are successfully recruited to S&E positions within their home economies. In contrast, a high proportion of foreign doctoral recipients from India and China remains in the United States, since these countries currently have a limited capacity to offer high-level S&E employment to the 14,000 scientists and 7,500 engineers from these countries who have been educated in the United States in the last 10 years. (See appendix table 2-43.)



In the 1990s, Asian-born scientists and engineers working in the United States have begun a small reverse flow from West to East. Some are attracted by new or expanded research facilities based in their home countries; these facilities are often part of the country's strong investment in R&D infrastructure as a strategy to develop indigenous high technolo-

Text table 2-11.

Major countries of origin of foreign-born

S&E faculty members in U.S. universities: 1993

Place of origin	Number	Percentage
Total S&E faculty	242,812	100.0
U.Sborn	193,606	79.7
Foreign-born ^a	49.206	20.3
S&E faculty from major	.,	
countries of origin	23,762	9.8
India	5,696	2.3
China	4,263	1.8
United Kingdom	3,149	1.3
Taiwan	2,491	1.0
Canada	2,206	0.9
South Korea	2,163	0.9
Germany	1,604	0.7
Iran	1,369	0.6
Greece	821	0.3
Other	25,446	10.5

^aThis includes scientists and engineers whose first job is in S&E postsecondary teaching at four-year colleges and universities in the United States; it excludes scientists and engineers who may teach as a secondary job.

See appendix tables 2-40 and 2-42.

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¹¹These data exclude S&E faculty members who teach in two-year and community colleges or who teach in an S&E field as a secondary job.

Text table 2-12. **S&E doctoral degrees awarded to Asian students by U.S. universities**

Place of origin	Cumulative 1986-95
Total Asia	44,931
China	14,088
Hong Kong	952
India	7,554
Japan	1,276
South Korea	8,821
Taiwan	10,276
Thailand	956
Other Asia	1,008
See appendix table 2-43. Science & Engineering	Indicators – 1

gies. By 1992, the combined R&D investments of six Asian countries reached almost \$100 billion in constant dollar terms, up from \$35 billion in 1982 (NSF 1993).

Asian countries offer opportunities for high-level employment in science as well as expanding R&D budgets that can fund the majority of proposed research within these countries. Taiwan has been able to recruit senior scientists and engineers who had previously emigrated to the United States as students and young scientists. In the late 1980s, returnees with science degrees numbered between 500 and 1,000 per year. These scientists, including some Nobel prize winners, were hired in Taiwan as senior faculty for expanding graduate programs and as laboratory directors, particularly at centers of excellence such as the Synchrotron Center in Hsinchi Science Park. (see "Chinese Students Drawn Back to Asia," 1996). The increasingly large numbers of Taiwan returnees with science degrees—over 2,000 per year—are, since 1992, competing for fewer jobs; S&E positions in government and universities, except for the newly established East China University, have largely been filled with early returnees. The Taiwanese government is providing two-year postdoctoral appointments within high-technology industries to many recent returnees. These high-technology industries, however, are hiring permanently only in targeted areas in which there is a scarcity of trained S&E personnel, such as superconductivity, and solid-state industries.

Newly established Asian universities have successfully begun to recruit Western-educated scientists and engineers to expanding S&E departments. For example, the large majority of Chinese and South Korean professors in the Hong Kong University of Science and Technology (HKUST) and South Korea's Pohang University of Science and Technology received their doctoral training in the United States. In addition to the large portion of U.S.-educated faculty in the major universities of Hong Kong, former U.S. faculty are the deans and heads of almost all of S&E departments and make up a large majority of the directors of HKUST research institutes. (See text table 2-13.)

Similarly, the National University of Singapore and its attached five research centers and six independent institutes are recruiting senior scientists from the United States as deans, department heads, and laboratory directors. Many Chineseborn U.S. scientists have been attracted to Singapore's world-class facilities and equipment, high salaries, generous research funding, and opportunity to contribute to the development of the Asian region through science and technology.

International Comparisons of S&E Training in Higher Education

International Comparison of Foreign Students

For many countries within the Asian region, the attraction of students to S&E is an important aspect of their economic growth strategy, including expanding access and participation of foreign students. Universities in Australia are aggressively recruiting foreign students, and the government is including the provision of educational services to Pacific Rim countries as part of its national economic planning. The longrange plan is to have 2.8 million foreign students by 2010

Text table 2-13. Leading scientists and engineers in Hong Kong universities, by country of Ph.D. award: 1996

University	Total	United States	United Kingdom	Canada	Australia	Hong Kong
Hong Kong University of Science and Technology						
Deans/department heads	15	14	0	1	0	0
Directors/research centers	16	12	3	1	0	0
Chinese University of Hong Kong						
Full professors	16	6	4	3	1	2
Directors/research centers	10	4	3	1	0	2

SOURCES: The Hong Kong University of Science and Technology, *Academic Calendar 1996-1997* (Kowloon, Hong Kong: 1996); and Chinese University of Hong Kong, *Calendar 1996-1997* (New Territories, Hong Kong: 1996).

Text table 2-14. **U.S. students studying in Japan**

		1995			1996	
Study level	Total U.S. students studying in Japan	With Japanese scholarship	Without Japanese scholarship	Total U.S. students studying in Japan	With Japanese scholarship	Without Japanese scholarship
Undergraduate	692	1	691	729	0	729
Graduate	255	127	128	271	137	134
Other	140	68	72	88	38	50

NOTE: For a description of Japanese exchange programs, see << http://www.twics.com/~nsftokyo/home.html>>.

SOURCE: National Science Foundation, Tokyo Office, unpublished tabulations (1997).

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Text table 2-15.

Foreign student enrollment in higher education in the United States and selected European countries

Country	Year	Total enrollment	Number of foreign students	Percentage of total enrollment
United States	1985/86	12,670,121	349,610	2.8
	1995/96	14,419,252	453,787	3.1
France ^a	1985/86	960,084	131,979	13.7
	1995/96	1,463,371	129,761	8.9
Germany	1985/86	1,550,211	79,354	5.1
	1993/94	1,875,099	116,474	6.2
United Kingdom	1985/86	1,032,491	53,694	5.2
	1992/93	1,528,389	95,594	6.3

^aFrench data are for universities only and do not include engineering schools, business schools, and professional schools.

SOURCES: UNESCO, Statistical Yearbook (Paris: 1996); Institute of International Education, Open Doors 1995-1996: Report on International Education Exchange (New York); and Ministère de l'Éducational Nationale, Repères et Références Statistiques sur les Enseignements et la Formation (Vanves, France: 1996).

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(Blight 1996). Japan currently educates 50,000 foreign students in its university system, mainly from China and South Korea. Through scholarships and fellowships, Japan seeks to double that number by the year 2000 (NSF 1997c). The number of U.S. students studying in Japan is growing, and includes many who have received Japanese scholarships. (See text table 2-14.) Taiwan, Singapore, Malaysia, and Hong Kong are replicating U.S. research universities and expanding their graduate S&E programs with Chinese students (Sales 1997).

Among European countries, foreign participation is attributable to a long-standing tradition of educating students from former colonies, as well as increased emphasis on European-wide exchanges. European countries have a higher percentage of foreign student enrollment than the United States when all levels of higher education are included. In 1995, foreign students accounted for between 6 and 9 percent of enrollment in higher education in selected European countries, com-

pared to about 3 percent in the United States. (See text table 2-15.) Among European countries, universities in Germany and France—with minimal or no tuition required for higher education—are receiving an increasing number of Western and Central European students. Germany is attempting to build up the higher education institutions in the former East Germany and Central Europe. While the percentage of foreign students is relatively low, they are concentrated at the doctoral level in Europe and the United States.

International Comparison of Doctoral Training

Increasing global capacity in S&E education is evident at the advanced degree level. This section presents aspects of doctoral degree preparation among selected countries of Asia, Europe, and North America, including overall degree production and participation of women and foreign students.

Europe leads North America and Asia in number of earned S&E doctoral degrees. In 1995, doctoral degrees awarded in S&E fields by Western and Eastern European institutions totaled 45,647—about 60 percent higher than the North American level and almost three times as many as the number recorded for Asian countries. (See text table 2-16 and appendix table 2-32.)

Text table 2-16. **Doctoral S&E degrees awarded, by world region:** 1995

T Field	North America			
Doctoral degrees,				
all fields	155,733	32,087	78,791	44,855
Science &				
engineering	89,818	15,678	45,647	28,493
Natural sciences	49,888	8,576	27,082	14,230
Social sciences	15,663	775	7,030	7,858
Engineering	24,267	6,327	11,535	6,405

NOTES: Natural sciences here include agricultural, mathematics and computer sciences. See appendix table 2-32 for countries included in each region.

See appendix table 2-32. Science & Engineering Indicators – 1998

Text table 2-17.

Share of doctoral S&E degrees earned by women in selected countries: 1995 (Percentages)

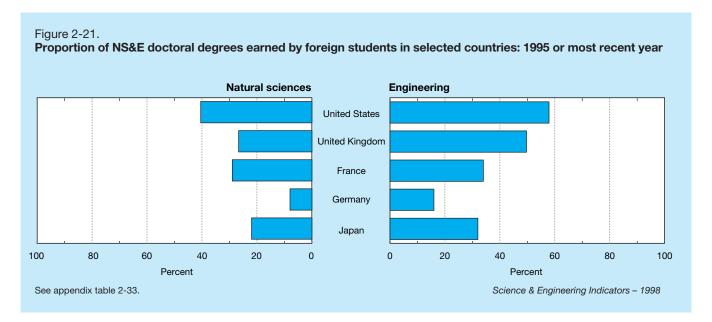
Field	United States	Germany	Franceª	United Kingdom	Japan ^b	South Korea	Taiwan
All S&E fields	31	22	NA	21	10	7	9
Natural sciences	32	26	35	34	11	13	17
Math & computer sciences	21	12	23	18	NA	13	13
Social sciences	50	34	45	33	25	10	23
Engineering	12	6	17	13	5	2	3

^aIn France, the natural sciences exclude the biological sciences, which are instead classified with health and medicine, and in which women earn 51 percent of the doctoral degrees. The social sciences include literature and the humanities.

bln Japan, mathematics and computer sciences are included in engineering. Percentages are based on university "coursework" doctoral degrees only, not those earned within industry.

SOURCES: **United States**—National Science Foundation, Science Resources Studies Division, Selected Data on Science and Engineering Doctorate Awards 1995, NSF 96-303 (Arlington, VA: 1996); **France**—Ministère de l'Éducation Nationale de l'Enseignement Supérieur et de la Recherche, Rapport sur les Études Doctorales (Paris: 1996); **Germany**—Statistisches Bundesamt Wiesbaden, Prüfungen an Hochschulen (Weisbaden: 1996); **United Kingdom**—Higher Education Statistics Agency, Students in Higher Education Institutions, 1995/96 (Cheltenham: 1997); **Japan**—Monbusho, Monbusho Survey of Education (Tokyo: annual series); **South Korea**—Ministry of Education, Stastistical Yearbook of Education (Seoul: 1996); **Taiwan**—Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996).

Science & Engineering Indicators - 1998



Comparing female representation in doctoral S&E degrees across countries, the United States ranks lower than France and higher than Germany. For example, within French universities in 1995, women earned a higher percentage of the NS&E doctoral degrees than did women in U.S. universities. (See text table 2-17.)

While graduate S&E programs are expanding rapidly in Asia, women have not yet entered those programs in large numbers. Women still earn only a small fraction of the doctoral S&E degrees issued in Asia. In fact, Asian women are more likely to obtain a doctoral degree in S&E fields from a U.S. university than from a home country university. For example, in 1995, women earned 7 percent of doctoral degrees in South

Korea, but 12 percent of the doctoral degrees earned by South Koreans in the United States. For women from Taiwan, the figures were 9 and 16 percent, respectively (NSF 1996d).

The United States, the United Kingdom, and France are the world's leading countries in terms of foreign students in S&E at the doctoral level. For example, 57 percent of the engineering doctoral degrees awarded in the United States in 1995 went to foreign students. (See figure 2-21.) In that same year, almost 50 percent of the engineering doctoral degrees awarded in the United Kingdom, and almost 30 percent of those awarded by French universities in the natural sciences, were earned by foreign students.

Conclusion

Centers of S&E knowledge are multiplying around the world, particularly in Europe, Asia, and North America. The increasing global capacity in S&E education has implications for the United States as well as other nations. Higher participation rates in S&E degrees and a greater focus on S&E fields in higher education in other countries contribute to the potential pool of scientists and engineers. Such human capital is important for addressing complex societal needs and for technological innovations. In addition, the global expansion of S&E knowledge has the potential benefits of quickening the pace of development in other world regions. A larger global capacity for S&E education implies a U.S. need to stay competitive through continual improvement of its precollege and higher education system.

Decisionmakers throughout the U.S. higher education system have introduced improved curricula and teaching at the undergraduate level to broaden participation of all groups in science and engineering. Recent participation rates in S&E, disaggregated by race/ethnicity and sex, show some domestic progress compared to a decade ago; this reflects a somewhat more diverse U.S. student population pursuing higher education in science and engineering, particularly at the undergraduate level. In the 1990s, the number of white enrollments in undergraduate education leveled off and began to decline, while enrollment for all minority groups increased. Similarly, while overall undergraduate engineering enrollment has been declining, enrollment of women and minorities has been increasing, particularly in the 1990s. At the bachelor's level, the number of degrees earned by underrepresented minorities is increasing slightly in NS&E fields, and very rapidly in the social sciences. These trends bear watching as individual states introduce systemic reforms and other public policy changes for improved S&E curricula and teaching at all levels.

In graduate education, there has been some progress for women in S&E programs, and very slight progress for underrepresented minorities. At the master's level, women have made significant progress in earned degrees in the natural sciences, but minority groups showed only modest growth in these fields. At the doctoral level, the share of S&E degrees earned by women approximately doubled from 16 percent in 1975 to 31 percent in 1995. Minority students have slightly increased their proportion of doctoral S&E degrees to almost 5 percent in 1995, but they are still at low levels of degree attainment.

The enrollment of foreign S&E graduate students in U.S. universities reached a peak in 1992, and has since declined. The rate of growth in S&E master's degrees earned by foreign students has slowed in the 1990s due primarily to a decline in earned degrees in the computer sciences. However, declining graduate enrollment of foreign students in engineering has not yet resulted in a fall-off of the number of master's degrees in engineering earned by foreign students. At the doctoral level, the proportion of S&E degrees earned by foreign citizens reached 40 percent in 1994 before leveling off.

The trend toward a somewhat lower concentration of foreign students in U.S. graduate programs is likely to continue, with fewer students from those places that are building their internal graduate S&E capacity, such as Taiwan and South Korea. The decline in foreign students from some Asian countries may be further exacerbated by the recent Asian economic crisis and the devaluation of currencies, making extended study abroad unaffordable.

The U.S. university system has accelerated the diffusion of S&E knowledge in the world through the education of foreign doctoral students, who have contributed both to the science and technology infrastructure in the United States and in their home countries. Many foreign doctoral recipients have remained in the United States for some time for further study or employment. As their home countries develop the need (and provide employment) for high-level skills, some of these foreign doctoral recipients return, bringing with them both their S&E education and U.S. work experience, further accelerating globalization of S&E. This improves other countries' economic competitiveness, as well as enhances the global good of improved scientific knowledge and world economic development. U.S. higher education is also enriched by the network of former doctoral students and faculty in key research centers in Asia and Europe. The benefits include enhanced cooperative research opportunities, expanded opportunities for U.S. graduate and undergraduate students to study abroad, and international postdoctoral research positions for young U.S. scientists and engineers.

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Science and Engineering Workforce

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Highlights

LABOR MARKET CONDITIONS

- ♦ Overall labor market conditions were similar in 1993 and 1995, despite many changes in conditions for specific S&E fields. Overall unemployment rates for science and engineering (S&E) Ph.D.-holders went from 1.6 percent to 1.5 percent. For recent Ph.D. recipients, the unemployment rate grew from 1.7 to 1.9 percent.
- ♦ Only 2.4 percent of recent S&E Ph.D. recipients reported working in a non-S&E job that was unrelated to their field. Based on the proportions reporting that they were involuntarily working outside of their field, the disciplines in which recent Ph.D. graduates found it most difficult to locate in-field employment in 1995 were political science (11.2 percent); mathematics (9.3 percent); sociology/anthropology (9.1 percent); earth, atmospheric, and oceanographic sciences (6.8 percent); and physics (6.7 percent). The biological sciences fared better, with 2.8 percent reporting involuntary outside-of-field employment; other measures, however, suggest a drop in the availability of tenure-track positions for recent biological sciences graduates.
- ♦ Most holders of Ph.D.s in science and engineering do not work in academia. Only 28.4 percent are employed as postsecondary teachers, and another 15.5 percent have some other employment at a four-year educational institution.
- ♦ Only 12.1 percent of scientists and engineers in postdoctoral positions in 1993 were in tenure-track positions in 1995; 41.6 percent still held postdoctorate appointments. Nevertheless, the length of time spent in postdoctoral positions appears to be only slightly greater than that reported retrospectively by those in mid-career.
- ♦ While most individuals in postdoctorate positions in 1995 reported additional training and other customary reasons for accepting their appointments, 17.1 percent said that they had taken a postdoctorate because other employment was not available. This proportion rises to 29.3 percent for the earth, atmospheric, and oceanographic sciences and to 26.8 percent for physics.

CHARACTERISTICS OF THE S&E WORKFORCE

- ♦ Almost 3.2 million people with a bachelor's degree or higher were employed in an S&E occupation in 1995. Engineers represented 42 percent (1.34 million) of all those in S&E occupations, followed by computer and math scientists with 30 percent (950,000) of the total. Physical scientists accounted for less than 10 percent of the S&E workforce in 1995.
- ♦ The pattern of S&E degree production at each degree level over the last 50 years—rapid growth followed by a recent slowdown—creates a likely demographic pattern in the S&E labor force with several implications. First, the number of scientists and engineers nearing traditional retirement ages will increase steadily and dramatically over the next 25 years. Second, even if there is no growth in the number of new S&E degree recipients, the size of the S&E-trained labor force will continue to increase for some time as the number of new entrants exceeds retirements and deaths. Finally, if degree production grows at a slower rate than in the past, the average age of scientists and engineers in the labor force will increase—with mixed implications for different aspects of research productivity.

INTERNATIONAL CONTEXT

♦ A lower bound estimate of U.S. native-born S&E Ph.D. graduates living abroad is 13,900—3.3 percent of all such Ph.D. recipients. If foreign-born doctoral recipients with U.S. citizenship or permanent residency at the time of their degrees are included, this figure rises to 19,600 (4.1 percent of the total).

PROJECTED DEMAND

◆ During the 1996-2006 period, employment in S&E occupations is expected to increase at more than three times the rate for all occupations. While the economy as a whole is anticipated to provide approximately 14 percent more jobs over this decade, employment opportunities for S&E jobs are expected to increase by about 44 percent or about 1.36 million jobs.

Introduction

Chapter Overview

Scientists and engineers play vital roles in the technological performance of U.S. industry in such areas as product or process innovation, quality control, and productivity enhancement. In addition, they conduct basic research to advance the understanding of nature, perform research and development (R&D) in a variety of areas such as health and national defense, train the nation's future scientists and engineers, and improve the scientific and technological literacy of the nation.

In the early 1990s, the U.S. science and engineering (S&E) workforce faced new and different challenges from those it experienced in the 1980s. A sluggish recession recovery, cutbacks in defense-related spending, reduced R&D budgets, and industry downsizing slowed the growth of S&E employment. Manufacturing S&E employment declined for the first time in more than a decade, while unemployment rates rose. Despite these trends, scientists and engineers have fared better than almost any other kind of worker. Moreover, the tight labor market has not precluded some S&E-trained individuals from finding meaningful, challenging work opportunities outside traditional S&E occupations.

Chapter Organization

This chapter first examines labor market conditions for recent bachelor's, master's, and doctoral S&E degree recipients. Information on the sex and racial/ethnic composition of the S&E workforce is next presented, followed by a description of S&E job trends in the service sector. The chapter provides data on foreign-born scientists and engineers, and presents comparisons regarding international R&D employment. It concludes with a brief section on the projected demand for S&E workers over the 1996-2006 decade.

Labor Market Conditions for Recent S&E Degree-Holders

Bachelor's and Master's Degree Recipients¹

Recent S&E bachelor's and master's degree recipients are a key component of the nation's science and engineering workforce: they account for almost half of the annual inflow to the S&E labor market (NSF 1990, p. 40). The career choices of recent graduates and their entry into the labor market affect the balance between the supply of and demand for scientists and engineers in the United States. Analysis of the workforce

status and other characteristics of recent S&E graduates can yield valuable labor market information. This section provides several labor market measures, including median annual salaries and in-field employment rates, that offer useful insights into the overall supply and demand conditions for recent S&E graduates in the United States.

Median Annual Salaries

In 1995, the highest median annual salaries of recent college graduates employed full time were earned by those with engineering degrees. The median annual salary for graduates with a bachelor's degree in engineering was \$33,500; it was \$44,000 for those with a master's degree. (See appendix table 3-1.) When compared with the salaries for recent science graduates with bachelor's degrees (\$22,900) and master's degrees (\$35,000), it is apparent that choice of a college major may significantly affect the salaries of recent college graduates entering the labor market.

School Versus Employment

About one out of four recent S&E bachelor's and master's degree recipients was enrolled in graduate school on a full-time basis in 1995. Students who had majored in the physical and life sciences were more likely to be going on to graduate school as full-time students than were those with degrees in mathematics and the computer sciences or engineering.

In-Field Employment

Success in the job market varies significantly by level and field of degree. One measure of success is the likelihood of finding employment directly related to a graduate's field of study. S&E master's degree recipients were more likely than bachelor's graduates to find work directly related to their field of study. Approximately one-half of all master's S&E degree recipients—but only a fifth of all S&E bachelor's recipients—were employed in their field of study in 1995. Among both master's and bachelor's degree recipients, students who had received their degrees in either engineering or the computer sciences were more likely to be working in their field of study. Students majoring in the social sciences were less likely to have jobs directly related to their degrees.

Employment Sectors

The private sector is by far the largest employer of recent bachelor's and master's degree recipients. In 1995, 59 percent of bachelor's degree recipients and 47 percent of master's degree recipients were employed in a private for-profit company. (See appendix table 3-2.) The academic sector is the second largest employer of recent S&E graduates. Master's degree recipients were more likely to be employed in four-year colleges and universities (23 percent) than were bachelor's degree recipients (13 percent). The federal sector employs only 7 percent of S&E master's degree recipients and 4 percent of S&E bachelor's degree recipients. Engineering graduates are more likely than science graduates to find employment in the federal sector. Sectors employing smaller numbers of recent

¹Data in this section are taken from the 1995 National Survey of Recent College Graduates. This survey collected information on the 1995 workforce/other status of 1993 and 1994 bachelor's and master's degree recipients in S&E fields. Surveys of recent S&E graduates have been conducted biennially for the National Science Foundation since 1978. For information on standard errors associated with survey data, see NSF (1997b).

S&E graduates include educational institutions other than fouryear colleges and universities, private nonprofit organizations, and state or local government agencies.

Doctoral Degree Recipients

Concerns have been raised about labor market opportunities for new Ph.D. scientists and the possible consequences on the health of scientific research in the United States.² Several recent developments have contributed to these concerns, including demographic changes (which have slowed the growth in undergraduate enrollment), reductions in defense and research funding, growth in the importance of Ph.D. programs at foreign schools (see chapter 2, "Worldwide Increase in S&E Educational Capabilities"), and rates of Ph.D. production that approach or exceed the high levels realized at the end of the Vietnam draft.

Since the 1950s, the Federal Government has actively encouraged graduate training in science through a number of mechanisms. However, widespread unemployment or involuntary movement out of S&E by large numbers of new Ph.D. scientists and engineers could have various adverse effects on the health of scientific research in the United States. If labor market difficulties are real but temporary, promising students may be discouraged from pursuing degrees in S&E fields. Eventually, this circumstance could reduce the ability of industry, academia, and government to perform R&D. If labor market difficulties are long term, restructuring will need to take place within graduate education and federal research support to maintain quality research. In either case, when much high-level human capital goes unused, society loses potential opportunities for new knowledge and economic advancement—and individuals feel frustrated in their careers.

Aggregate measures of labor market conditions for recent Ph.D. recipients (one to three years since degree) changed only slightly between April 1993 and April 1995.³ The unemployment rate for all recent Ph.D. recipients rose from 1.7 percent in 1993 to 1.9 percent in 1995. (See text table 3-1.) The rate of recent Ph.D.s involuntarily working outside of their degree fields rose slightly, from 4.0 percent in 1993 to 4.3 percent in 1995. These aggregate numbers mask much larger changes in labor market conditions—both positive and negative—within individual disciplines.

Most individuals who complete an S&E doctorate are looking for more than just steady employment at a good salary. Their technical and problem-solving skills make them highly employable, but the opportunity to do the type of work they want and for which they have been trained is important to

them. For that reason, no single measure can well describe the S&E labor market. Some of the available labor market indicators are discussed below.

Unemployment Rates

Only 1.9 percent of recent (one to three years after degree award) Ph.D. recipients were unemployed in April 1995. (See text table 3-1.) This number is low compared to the 5.7 percent unemployment rate for all civilian workers, and is only slightly higher than the 1.5 percent rate for S&E doctoral recipients. In several fields, however, new Ph.D.s faced higher unemployment rates: 4.3 percent in chemical engineering, 4.0 percent in mathematics, 3.2 percent in sociology/anthropology, and 2.9 percent in physics. While still much lower than for the general population, these unemployment rates are unusually high for a highly skilled group. For recent physics Ph.D.s, however, the 2.9 percent rate represents a large drop from the 5.3 percent unemployment rate reported by the 1993

Text table 3-1.

Labor market rates for recent Ph.D.s, by degree field (Percentages)

			Involu out-of	-field
	Unemp	loyed	employ	ymen
Ph.D. degree field	1993	1995	1993	1998
All S&E	1.7	1.9	4.0	4.3
Life sciences	0.9	2.0	2.6	2.6
Agricultural sciences	1.1	1.1	2.7	2.2
Biological sciences	0.7	2.2	2.3	2.8
Health/medical sciences	1.5	1.3	2.1	2.2
Math and computer sciences	1.1	2.6	4.9	6.2
Mathematics	0.7	4.0	7.1	9.3
Computer sciences	1.5	1.1	2.1	2.7
Physical sciences	3.0	2.4	5.4	5.3
Chemistry	1.6	2.1	4.0	4.1
Earth, atmospheric &				
oceanographic		1.7	8.5	6.8
Physics	5.3	2.9	6.1	6.7
Social sciences	1.8	1.4	4.6	5.5
Economics	2.1	1.4	4.1	2.7
Political science	2.4	2.5	5.1	11.2
Psychology	1.4	0.5	2.2	3.8
Sociology/anthropology	3.3	3.2	11.6	9.1
Engineering	1.9	1.7	3.7	3.7
Chemical	1.1	4.3	2.1	3.3
Civil	1.9	1.3	1.4	1.0
Electrical	1.9	0.9	3.8	3.0
Mechanical	1.3	2.8	8.3	5.0

NOTE: Recent Ph.D.s are those who received their degrees one to three years previously.

SOURCE: National Science Foundation, Science Resources
Studies Division, Survey of Doctorate Recipients, merged 1993 and
1995 files. Science & Engineering Indicators – 1998

²For a more detailed discussion, see COSEPUP (1995).

³This section primarily uses data from the 1993 and 1995 Survey of Doctorate Recipients (SDR), a biennial National Science Foundation (NSF) survey of doctorate-holders from U.S. institutions up to age 75; and the closely related Scientists and Engineers Statistics Data System (SESTAT) integrated file which contains data from the SDR and two other NSF surveys, the National Survey of College Graduates and the National Survey of Recent College Graduates. For more information on SDR, see chapter 5, "Data Sources: Nature, Problems, and Comparability."

⁴People are said to be unemployed if they were not employed during the week of April 15, 1995, and had either looked for work during the preceding four weeks or were on layoff from a job.

cohort. On the other hand, the rates for mathematics and chemical engineering are notably greater than the negligible 0.7 and 1.1 percent rates reported respectively in 1993.

Involuntarily Working Outside of Field

Another 4.3 percent of recent S&E Ph.D. recipients in the labor force reported that they could not find full-time employment "closely related" or "somewhat related" to their degrees. These persons are considered to be IOF—involuntarily out-of-field. This definition of IOF includes those working part time in their fields because full-time work was not available.

As with unemployment, IOF rates varied greatly by field, with 11.2 percent in political science; 9.3 percent in mathematics; 9.1 percent in sociology/anthropology; 6.8 percent in earth, atmospheric, and oceanographic sciences; and 6.7 percent in physics. (See text table 3-1.) Fields with relatively low IOF rates for recent Ph.D.s included 1.0 percent in civil engineering, 2.2 percent for both agricultural and medical sciences, 2.7 percent for both economics and computer sciences, and 2.8 percent in the biological sciences.

Tenure-Track Positions

Most S&E Ph.D. recipients do not work in academia. (See "How Traditional Is an Academic Career?"; but also see chapter 5, "The Academic Doctoral S&E Workforce.") Across all fields and ages, only 30.8 percent of S&E Ph.D.s in the labor force are in tenure-track or tenured positions at four-year educational institutions. (See text table 3-2.) Across fields, academic tenure-track employment varies from a high of 54.0 percent for economics to a low of 14.0 percent for chemical engineering. Still, the availability of tenure-track positions is an important aspect of the job market for those who do seek academic careers.

In 1995, 15.9 percent of recent S&E Ph.D. recipients were in tenure-track positions. (See text table 3-2.) This proportion rose to 26.8 percent among those who had received their doctorates within the previous four to six years; it was greater still (30.5 percent) for those at mid-career—11 to 20 years after degree. The percentage of Ph.D.s with tenure-track positions does not, however, reveal much about how difficult it is to obtain academic employment—in fields where many new Ph.D.s prefer employment in industry, there may actually be less competition for academic jobs.

Comparable historical data on tenure-track rates in early career are not available, but comparisons with mid-career tenure-track rates do provide an imperfect indicator of changes in the availability of academic positions. By this relative measure, early career tenure-track rates (four to six years out) are noticeably lower in the biological sciences (-14.4 percentage points), agriculture (-10.1), chemical engineering (-8.6), and physics (-4.7).

The differences in tenure-track rates in the biological sciences are a notable part of a complicated labor market profile for that field. Both unemployment and IOF rates are relatively low in the biological sciences. However, salaries are

also lower—and, evidently, so are the opportunities for tenure-track academic employment.

Relationship Between 1995 Occupation and Degree Field

By a strict definition of occupational titles, 31.5 percent of employed recent Ph.D.s were in occupations outside science and engineering, often with administrative or management functions. When asked how related their jobs were to their highest degree, only a small proportion of recent Ph.D.s in non-S&E occupations said that their jobs were unrelated to their degree. (See text table 3-4.) By field, these respondents ranged from 1.5 percent of recent engineering Ph.D. graduates to 4.5 percent of recent Ph.D. graduates in mathematics and the computer sciences.

Changes in Employment Status

Of the 72.2 percent of recent S&E Ph.D. recipients who were in "regular" employment in 1993 (that is, not in a postdoctorate appointment and not involuntarily working outside of their fields), the vast majority—94 percent—were still in regular employment in 1995. (See figure 3-1.) Of those in other 1993 employment statuses (postdoctorate, IOF, or unemployed), 50 percent of each group had moved to regular employment by 1995. Forty-five percent of 1993

Text table 3-2.

Scientists and engineers holding tenure and tenure-track appointments at four-year institutions, by degree field and years since Ph.D. award: 1995
(Percentages)

	Early	career	Mid-c	Mid-career	
	1-3	4-6	11-20	All	
Ph.D. degree field	years	years	years	years	
All S&E	15.9	26.8	30.5	30.8	
Agricultural sciences	13.4	26.0	36.1	32.8	
Biological sciences	8.8	19.8	34.2	32.5	
Health/medical sciences	32.5	45.2	37.9	39.0	
Mathematics	36.0	52.7	51.3	53.5	
Computer sciences	34.5	42.3	38.9	40.9	
Chemistry	6.9	14.6	15.1	18.8	
Earth, atmospheric &					
oceanographic sciences	10.9	30.1	27.3	28.8	
Physics	5.8	15.6	20.3	23.5	
Economics	42.4	55.4	52.2	54.0	
Political science	29.5	68.4	51.6	52.7	
Psychology	13.1	19.8	19.8	22.1	
Sociology/anthropology	32.2	50.4	49.2	49.9	
Chemical engineering	6.6	6.0	14.6	14.0	
Civil engineering		29.9	33.7	34.5	
Electrical engineering	10.8	22.5	26.4	22.9	
Mechanical engineering	14.4	26.3	24.2	23.3	

SOURCE: National Science Foundation, Science Resources Division, 1995 Survey of Doctorate Recipients.

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How Traditional Is an Academic Career?

It has long been known from the Survey of Doctorate Recipients (SDR) and other labor force surveys that a large majority of doctorate level scientists and engineers, at any one point in time, work outside academia. The 1995 Scientists and Engineers Statistics Data System (SESTAT) Work History Module, combined with the 1995 SDR core questions, provides current and retrospective career information that allows mapping of typical career paths.

Text table 3-3 divides the population of employed S&E doctorate-holders into four groups: those currently employed as postsecondary teachers, those currently in

Text table 3-3.

Current or former employment of S&E Ph.D.s as postsecondary teachers, by field: 1995 (Percentages)

Ph.D. degree field	Current post- secondary teacher	,	t post- secondary	Never post- secondary teacher
All S&E	28.4	15.5	9.4	46.7
Life sciences	25.7	23.8	6.9	43.6
Math and compute	er			
sciences	48.5	9.4	11.7	30.4
Physical sciences.	22.6	14.6	8.5	54.3
Social sciences	35.6	11.6	12.6	40.1
Engineering	20.3	10.9	8.4	60.4

NOTE: Data are for those employed as of April 1995.

SOURCE: National Science Foundation, Science Resources Studies
Division, 1995 SESTAT (Scientists and Engineers Statistics Data System),
Work History Module. Science & Engineering Indicators – 1998

Text table 3-4.

Comparison of degree field and occupation field for recent S&E Ph.D.s: 1995 (Percentages)

		Occupation field				
Ph.D. degree field	Same as degree			Unrelated non-S&E		
All S&E	61.5	7.0	29.1	2.4		
Life sciences	58.0	4.6	35.6	1.8		
Math and						
computer sciences	65.1	3.6	26.8	4.5		
Physical sciences	59.8	10.3	27.4	2.5		
Social sciences	69.5	4.2	23.1	3.2		
Engineering	55.9	12.0	30.6	1.5		

NOTE: Recent Ph.D.s are those who received their degrees one to three years previously.

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 Survey of Doctorate Recipients.

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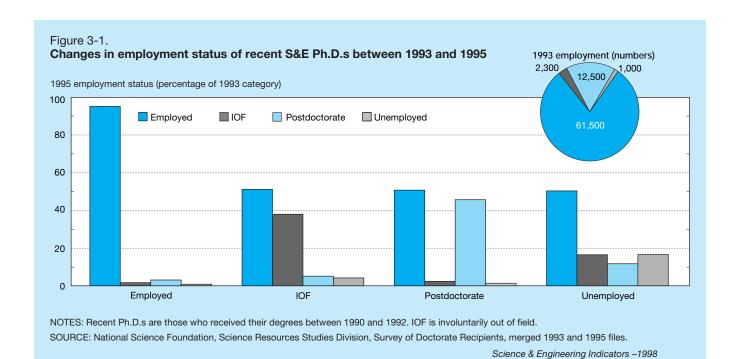
nonteaching jobs at four-year institutions, those who were formerly postsecondary teachers at some time after completion of their Ph.D.s, and those not currently employed in academia and who reported no postsecondary teaching positions since completion of their Ph.D.s. (Note that tenured administrators and other nonteaching faculty make up most of the difference between the percentage in postsecondary teaching positions and those with tenure or in tenure-track positions; also note that many nonteachers employed in academia also report being former postsecondary teachers.) One weakness of this analysis based on occupation is that it does not capture the past academic affiliations of scientists and engineers who are hired as administrators or researchers without ever being part of the teaching faculty.

A small majority—53.3 percent—of employed S&E doctorate-holders in 1995 were either currently in academia or reported past employment as postsecondary teachers since receiving their degrees. There is less academic involvement in engineering and the physical sciences, where majorities report never having been employed as postsecondary teachers or having no current employment in academia. It is also noteworthy that even in mathematics and the computer sciences, where employment in academia is heaviest, a large majority of currently nonacademic scientists and engineers appears never to have held academic teaching jobs. This view is consistent with shorter career views obtained by longitudinal matching of the SDR data; these data show relatively little movement between academia and industry, excluding new graduates and postdoctorates.

postdoctorates were still in a postdoctorate position in 1995; 37 percent of those working involuntarily outside of their fields were IOF in 1995 as well. There was, however, much less evidence of long-term unemployment: only 0.3 percent were unemployed in both 1993 and 1995.

Median Annual Salaries

The median salary earned by recent science and engineering Ph.D. recipients in 1995 was \$40,000, with the highest median found for engineering Ph.D.s (\$54,000) and the lowest for Ph.D.s in the life sciences (\$32,000). Despite the wide variety of employment types and fields for new Ph.D. recipients, there is a fairly narrow distribution of salaries around this median—the 10th percentile makes \$22,500 and the 90th percentile, \$65,000. (See text table 3-5.) The lowest 10th percentile salary (\$8,000) is found for recent Ph.D. recipients in sociology/anthropology. The highest 90th percentile salary was \$85,000, for recent Ph.D. recipients in the computer sciences and economics.



Text table 3-5. Salary distribution for recent S&E Ph.D.s, by degree field: 1995 (Dollars)

	Percentile				
Ph.D. degree field	10th	25th	Median	75th	90th
All S&E	22,500	30,000	40,000	54,400	65,000
Life sciences	22,000	26,000	32,000	43,500	58,000
Agricultural sciences	24,000	26,500	37,949	47,900	55,000
Biological sciences	21,000	25,000	30,000	37,000	52,000
Health/medical sciences	25,000	35,480	45,000	55,000	65,000
Math and computer sciences	28,500	35,000	45,000	60,000	75,000
Mathematics	25,000	32,000	36,000	47,000	64,000
Computer sciences	40,000	44,500	55,000	70,000	85,000
Physical sciences	22,000	30,000	38,000	52,000	61,000
Chemistry	20,000	27,000	42,000	55,000	62,000
Earth, atmospheric & oceanographic	25,000	32,000	37,000	46,000	60,000
Physics	24,000	30,000	36,000	50,000	60,000
Social sciences	19,600	30,000	38,000	49,850	67,933
Economics	36,000	42,000	48,000	60,000	85,000
Political science	25,000	32,000	37,000	50,500	71,600
Psychology	18,500	28,000	37,500	48,500	67,000
Sociology/anthropology	8,000	25,600	33,000	40,000	52,700
Engineering	32,000	43,000	54,000	63,000	72,000
Chemical	31,000	46,000	58,200	65,000	68,000
Civil	35,000	43,000	48,000	55,400	66,600
Electrical	38,000	50,000	60,000	68,000	79,600
Mechanical	36,000	45,000	52,000	60,000	67,000

NOTE: Recent Ph.D.s are those who received their degrees one to three years previously.

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Another meaningful way to view new doctorate salaries is by sector of employment. Median salaries in 1995 for recent Ph.D.s were highest in the private, noneducation sector (\$56,000) and lowest for postdoctorates (\$28,000). (See text table 3-6.) Government salaries tended to be just slightly above those of tenure-track positions in academia. While the pattern of salary by degree field also varied by sector of employment, salaries were generally higher in engineering and math/computer sciences and lower in the social and life sciences.

Postdoctorate Appointments

A postdoctoral appointment is defined here as a temporary position awarded in academia, industry, or government primarily for the purpose of gaining additional training in research. This definition is used in the 1995 Survey of Doctorate Recipients to ask respondents about current and past postdoctorate positions they have held.⁶

Data and analyses on postdoctorates are closely related to recent Ph.D. labor market issues. In addition to gaining more training, recent Ph.D. recipients may accept a temporary, usually lower paying, postdoctorate position because a more permanent job in their field is not available. NSB (1996) reported that there was no strong evidence that the number or length of postdoctorate positions was being driven by changes in labor market conditions. With the new data provided by an extensive postdoctorate module in the 1995 Survey of Doctorate Recipients, some labor market effects can now be discerned in some specific disciplines.

Reasons for Taking a Postdoctorate. The most commonly reported reason given by 1995 postdoctorates for taking a postdoctorate appointment was to acquire additional training

in their Ph.D. field (35.4 percent).⁷ Other respondents reported that they were taking a postdoctorate to receive training outside of their respective Ph.D. field⁸ (18.5 percent) or to work with a particular researcher or institution (21.5 percent). Text table 3-7 shows reported reasons for taking a postdoctorate in the six fields that accounted for 92 percent of 1995 S&E postdoctorate appointments.

Beyond these traditional uses of a postdoctorate, 17.1 percent of respondents reported that they accepted a postdoctorate appointment because other employment was not available. This proportion rises to 29.3 percent in the earth, atmospheric, and oceanographic sciences and to 26.8 percent in physics—two fields with relatively high unemployment and IOF rates among recent Ph.D. graduates.

Incidence and Length of Postdoctorate Appointments.

Although there are some postdoctorate positions in all academic disciplines, most are concentrated in a small number of fields in which postdoctorate appointments are part of a traditional career path. Although some scientists and engineers appear to take postdoctorate positions at all points in their careers, they usually do so within a few years of completing their doctorate. (See figure 3-2.) The incidence of postdoctorate appointments is greatest in the biological sciences and physics, but few are in postdoctorate positions in these fields beyond six years after degree award.⁹

Text table 3-8 provides information from the SDR Postdoctorate Module on the proportion of each graduation cohort that ever held a postdoctorate position and the median

Text table 3-6. Salaries of recent S&E Ph.D.s, by degree field and employment sector: 1995 (Dollars)

Ph.D. degree field	Private, noneducational	Government	Tenure track	Postdoctorate	Other education
All S&E	56,000	46,000	41,300	28,000	35,000
Life sciences	52,000	42,500	42,500	26,500	33,900
Math and computer sciences	65,000	61,250	43,000	35,000	35,900
Physical sciences	55,000	52,000	38,000	30,000	34,000
Social sciences	48,000	44,784	38,200	27,000	34,000
Engineering	60,000	52,000	49,300	33,000	43,000

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 Survey of Doctorate Recipients.

⁵Salaries reported on an "academic year" basis have not been adjusted upwards, as was done in pre-1996 volumes of *Science & Engineering Indicators*.

⁶It is clear, however, that the exact use of the term "postdoctorate" differs among academic disciplines, among different universities, and among the different sectors that employ postdoctorates. It is likely that these differences in labeling affected self-reporting of postdoctorate status on the Survey of Doctorate Recipients.

⁷A recent joint National Science Foundation-French National Center for Scientific Research (CNRS) project to study French doctorates and postdoctorates in the United States showed a similar pattern. Although not a fully representative sample, many of the respondents noted that the reason they took a postdoctorate in the United States was to improve their job opportunities in France (see Terouanne 1997).

⁸Many respondents to this question may have interpreted "field" very narrowly, so training outside of their field may simply refer to a subfield of their discipline that lies outside their dissertation work.

⁹The profile of those who had a postdoctorate in 1995 does not reveal much about the length of time spent in postdoctoral appointments—a person in a postdoctorate six years after obtaining a Ph.D. may have just begun the appointment. The profile also does not reveal much about how postdoctorates today differ from their historical patterns.

Text table 3-7.

Reasons for taking current postdoctorate, by field: 1995 (Percentages)

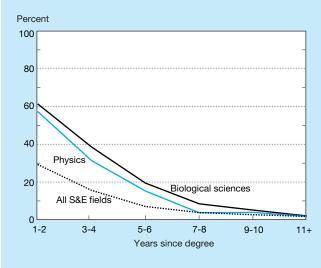
Ph.D. degree field	Additional training in Ph.D. field	Training outside of Ph.D. field	Work with a particular person or place	Other employment not available	Other
All S&E	35.4	18.5	21.5	17.1	7.5
Agricultural sciences	38.1	13.7	11.8	20.6	15.8
Biological sciences	38.6	23.2	20.9	11.1	6.3
Chemistry Earth, atmospheric	26.3	13.0	18.4	21.8	10.4
& oceanographic sciences	25.2	3.4	38.7	29.3	3.4
Physics	33.1	12.1	21.6	26.8	6.5
Psychology	43.0	11.5	21.7	13.1	10.8

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 Survey of Doctorate Recipients, Postdoctorate Module.

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Figure 3-2.

Percentage of Ph.D.s in postdoctorate positions, by years since degree: 1995



SOURCE: National Science Foundation, Science Resources Studies Division, 1995 Survey of Doctorate Recipients.

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number of months in postdoctorates for those who held them. ¹⁰ For the more recent cohorts, particularly those only one to three years since degree, length of time in postdoctorate is constrained by the limited time they have held their degrees.

Across all fields, the Postdoctorate Module shows a steady increase over time in both the incidence and length of postdoctorate experiences. It is difficult to tie these trends directly to labor market events or even to claim a consistent pattern across fields. In physics, chemistry, and psychology—

Text table 3-8.

Incidence and length of postdoctorate appointments, by selected S&E fields: 1995

		Years	since	Ph.D.	degree		
Field	1-3	4-6	7-10	11-20	21-30	31+	
Percentage ever	Percentage ever in postdoctorate appointment						
All S&E	41.3	37.9	36.3	34.0	29.2	25.0	
Agricultural sciences	43.9	43.9	35.0	27.6	19.2	14.0	
Biological sciences	71.0	71.5	71.8	66.3	51.2	39.9	
Chemistry	63.0	57.7	55.2	46.1	50.6	30.5	
Earth, atm. &							
ocean. sciences	48.5	52.3	40.0	37.3	21.4	15.3	
Physics	72.9	68.1	59.0	52.7	44.4	29.3	
Psychology	31.8	23.6	27.3	25.3	21.3	22.5	
Months spent i	n post	docto	rate ap	pointn	nent		
All S&E	18	29	29	26	23	20	
Agricultural sciences	20	20	22	25	25	12	
Biological sciences	23	46	45	38	28	24	
Chemistry	19	22	24	22	23	16	
Earth, atm. &							
ocean. sciences	17	23	19	16	12	14	
Physics	23	34	32	25	24	23	

NOTES: Fields selected are those with a high incidence of postdoctorate appointments. "Months spent in postdoctorate appointment" refers to the median of the sum of the lengths of each reported postdoctorate experience.

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SOURCE: National Science Foundation, Science Resources Studies Division, 1995 Survey of Doctorate Recipients, Postdoctorate Module.

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fields with distinct labor markets—the incidence of postdoctorates between one to three and four to six years after degree has risen, despite the lesser opportunity of the younger cohort to obtain a postdoctorate. In psychology, the agricultural sciences, and chemistry, there is no trend toward longer

¹⁰Recall bias may well lead to underreporting of postdoctorate experiences by older cohorts, but this occurrence may be less problematic than comparisons of reported postdoctorate rates among the sometimes dissimilar survey instruments used over the years. For length of appointment, up to three postdoctorates reported in the Postdoctorate Module are aggregated.

postdoctorate appointments. In the biological sciences, even the mid-career cohort—11 to 20 years after degree—had a very high incidence (66.3 percent) and length (38 months) of postdoctorate positions.

Postdoctorate Transitions: What Were 1993 Postdoctorates Doing in 1995? Of those in postdoctorate positions in April 1993, 41.6 percent were still in a postdoctorate position in April 1995. (See text table 3-9.) Only 12.1 percent transitioned from a postdoctorate to a tenure-track position at a four-year educational institution; 21.2 percent found other positions at educational institutions, and 16.6 percent went to work for a private for-profit firm.

The percentage of postdoctorates obtaining tenure-track positions is not large even for those with greater time since degree—only 18.8 percent of 1993 postdoctorates who were five to six years since degree were in tenure-track positions in 1995. (See text table 3-10.) This is, however, a much greater rate of transition to permanent academic jobs than for postdoctorates one to two years since degree (10.4 percent). One in five is still a low rate if an academic career is viewed as the primary objective of most Ph.D. scientists accepting a postdoctorate appointment at that point in their career.

For those in postdoctorates seven or more years after their degree, the rate of transition to tenure-track appointments drops to 9.8 percent. To a great extent, this rate is driven by career patterns in the biological sciences, where there have long been large numbers of Ph.D. scientists pursuing multiple postdoctorate appointments. However, in physics—where multiple postdoctorates are a more recent phenomenon¹¹—the percentage of postdoctorates transitioning to tenure-track appointments begins to drop much earlier (three to four years since degree), to 7.1 percent.

For both physics and the biological sciences, the unemployment rate in 1995 for 1993 postdoctorates was greatest

for those with more time since degree—3.4 percent for biological scientists seven or more years since degree and for physicists three to four years after degree. There was also an increase in the rate of transition to the "other education" category. This category includes some individuals who become adjunct faculty, but it primarily encompasses other nontenure-track research and administrative jobs at a university.

Selected Characteristics of the S&E Workforce

The data in this section are drawn from the National Science Foundation's (NSF's) Scientists and Engineers Statistical Data System (SESTAT),¹² which is a unified database containing information on the employment, education, and other characteristics of the nation's scientists and engineers. For a discussion of labor force indicators drawn from other surveys, see "The S&E Labor Market Since 1995: Indicators From Other Surveys."

Basic Characteristics

Of the approximately 3.3 million individuals in science and engineering occupations in the labor force in 1995, only 2.2 percent (70,600) reported themselves as unemployed. The highest unemployment rate was reported for physical

- ♦ non-institutionalized,
- ♦ not older than age 75, and
- ♦ either trained or working as a scientist or engineer—i.e., either had at least one bachelor's or higher degree in an S&E field or had a bachelor's or higher degree in a non-S&E field and worked in an S&E occupation as of the reference week.

For the 1995 SESTAT, the reference period was the week of April 15, 1995.

Text table 3-9. Employment status of 1993 postdoctorates, by S&E field: 1995 (Percentages)

Field	Post- doctorate	Tenure track at 4-year institution	Other education	Private for-profit	Private not- for-profit/ government	Unemployed
All S&E	41.6	12.1	21.1	16.6	6.9	1.6
Agricultural sciences	47.5	5.8	18.9	15.8	6.7	5.4
Biological sciences	47.8	12.0	20.5	12.9	4.9	1.9
Chemistry		13.2	12.5	32.0	6.4	0.9
Earth, atmospheric & oceanographic sciences		12.6	33.2	7.8	12.5	0.0
Physics	43.0	12.7	20.9	14.7	6.2	2.6
Psychology	34.4	11.3	28.2	15.1	11.0	0.0

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, merged 1993 and 1995 files.

¹¹See text table 3-8 for the historical pattern of postdoctorates. Due to the small numbers of physicists in postdoctorates beyond four years after their degree, there was not a sufficient sample size to estimate transition rates.

¹²SESTAT data are collected from three component surveys sponsored by NSF and conducted periodically throughout each decade: (1) the National Survey of College Graduates, (2) the National Survey of Recent College Graduates, and (3) the Survey of Doctorate Recipients. SESTAT's target population is residents of the United States with a bachelor's degree or higher (in either an S&E or non-S&E field) who, as of the study's reference period, were:

Text table 3-10.

Postdoctorate transitions by years since 1993 degree: 1995 (Percentages)

	1995 employment status of 1993 postdoctorates					
Postdoctorate field and years since 1993 degree	Tenure track	Post- doctorate	Other education	Non- education	IOF	Unemployed
All S&E	11.9	40.5	20.2	21.4	3.1	1.6
1-2 years	10.4	45.8	16.2	22.2	3.3	1.0
3-4 years	13.4	36.5	21.9	21.3	2.3	2.7
5-6 years	18.4	35.8	18.6	18.7	3.7	2.5
7 or more years	9.8	28.4	33.1	20.2	3.9	1.7
Biological sciences	11.6	46.5	19.2	15.8	2.8	1.9
1-2 years	6.3	58.8	15.6	14.1	3.1	0.7
3-4 years	16.5	38.0	19.5	19.1	1.6	2.9
5-6 years	20.1	35.6	18.2	16.2	3.7	2.5
7 or more years	13.4	27.9	34.2	14.2	4.1	3.4
Physics	12.5	42.3	20.6	17.6	3.3	2.6
1-2 years	14.0	47.5	13.5	16.8	5.9	1.9
3-4 years	7.1	35.8	35.2	15.5	0.0	3.4
5-6 years	n/s	n/s	n/s	n/s	n/s	n/s
7 or more years	n/s	n/s	n/s	n/s	n/s	n/s

n/s = not surveyed

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, merged 1993 and 1995 files.

NOTE: Some percentages may differ from those in text table 3-9 due to the inclusion of involuntarily out-of-field (IOF) employment.

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The S&E Labor Market Since 1995: Indicators From Other Surveys

Although detailed biennial surveys of individuals such as NSF's SESTAT allow examination of complex patterns and long-term trends in education and employment, they are less well-suited to tracking short-term changes in employment rates. Data from the 1997 NSF labor force surveys are still in the process of being collected, but other data may serve as indicators of changes in market conditions since April 1995. In general, these data suggest that labor market conditions are improving. This is consistent with improvements in the general economy, specifically with unemployment rates for all workers, as measured by the monthly Current Population Survey, which dropped from 5.7 percent in April 1995 to 4.7 percent in October 1997. Thus:

- ♦ The American Mathematical Society surveyed 1996-97 new recipients of mathematics Ph.D.s in the fall of 1997. This soon after graduation, the unemployment rate was a relatively high 6.8 percent. However, this rate represents a large decrease from the 14.7 percent unemployment rate found for the 1994-95 Ph.D. cohort two years earlier by the same survey.
- ♦ The American Institute of Physics estimated a 4.0 percent unemployment rate for the 1994-95 cohort of

- recipients of physics Ph.D.s in the winter after their degrees. The corresponding estimate of the previous year, for the 1993-94 cohort, was 5.0 percent unemployment.
- ♦ In 1997, several S&E professional societies, in collaboration with the Commission on Professionals in Science and Technology, coordinated their surveys of new Ph.D.s. Among other common survey items, recent Ph.D. recipients were asked to characterize on a scale of 1 to 5 (where 1 is strongly disagree and 5 is strongly agree) their agreement with various statements about their current jobs. Preliminary results are available for chemistry, chemical engineering, computer sciences, earth and space sciences, and psychology. New Ph.D.s in these fields showed much agreement that their current jobs were "at least somewhat related to my field" (average values within a field ranged from 4.3 for chemical engineering to 4.6 for the computer sciences); and that the job was "commensurate with my education and training" (mean scores of 4.1 to 4.4). However, there was less agreement with "position similar to what I expected to be doing when I began my doctoral program," with mean values ranging from 3.4 in psychology to 3.7 in the computer sciences.

scientists (2.7 percent) and the lowest for social scientists (1.2 percent). By degree level, only 2.1 percent of the scientists and engineers whose highest degree was a bachelor's degree and 1.8 percent of those with a doctorate were unemployed, compared to 2.5 percent of those with a master's degree. (See figure 3-3.)

Employment by Field

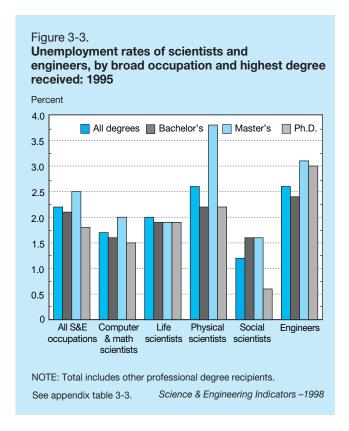
Engineers represented 42 percent (1.34 million) of the employed scientists and engineers in 1995; followed by computer and math scientists, who accounted for 30 percent (950,000) of the total. (See appendix table 3-4.) Physical scientists accounted for less than 10 percent of the S&E workforce in 1995. By subfield, electrical engineers made up about one-fourth (357,000) of all employed engineers, while biological scientists accounted for a little over half (169,000) of the employment in the life sciences. In physical and social science occupations, chemists (111,000) and psychologists (167,000) made up the largest occupational subfields, respectively.

Highest Degree Level

Almost 58 percent of those working in S&E occupations in 1995 reported their highest degree as a baccalaureate, while 28 percent listed a master's degree and 13 percent a doctorate. (See appendix table 3-4.) Other professional degrees were reported as the highest degree type achieved by about 1 percent of the S&E workforce. Almost half of those with bachelor's degrees were employed as engineers. (See text table 3-11.) Another 34 percent had jobs as computer and math scientists. These occupations were also the most popular among those with master's degrees (40 percent and 30 percent, respectively). Most doctorate-holders were employed in the social sciences (27 percent), life sciences (25 percent), and physical sciences (19 percent).

Relationship Between Occupation and Education

Approximately 83 percent (2.6 million) of those in the S&E workforce in 1995 had their highest degree in an S&E field; the exact proportions vary by highest degree level.



About 74 percent of master's degrees were in an S&E field, compared to 94 percent of doctoral degrees (NSF 1995c). By field, almost 77 percent of engineers and 80 percent of social scientists were working in their highest degree fields. Similar proportions existed among physical scientists (73 percent) and life scientists (71 percent). By contrast, over 57 percent of computer and math scientists reported their highest degrees to be in other fields. (See text table 3-12.)

A large number of people trained in S&E disciplines routinely find S&E-related employment in nontraditional S&E occupations. For example, approximately 4.7 million people with S&E degrees were employed in non-S&E occupations in 1995; about 65 percent of these reported that their work was at least somewhat related to their degrees. (See text table 3-13.) Approximately four-fifths of both doctoral and master's S&E de-

Text table 3-11. **Distribution of employed scientists and engineers, by broad occupation and highest degree received: 1995** (Percentages)

Occupation	Total	Bachelor's degree	Master's degree	Ph.D. degree	Other professional degree
All scientists and engineers	100.0	100.0	100.0	100.0	100.0
Computer and math scientists	29.8	33.9	30.0	12.9	8.8
Life scientists	9.6	6.6	7.2	24.5	56.7
Physical scientists	8.6	6.9	7.5	18.9	0.6
Social scientists	10.0	3.3	15.2	27.1	25.8
Engineers	42.0	49.3	40.1	16.7	8.1

See appendix table 3-4.

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Text table 3-12. Distribution of employed scientists and engineers, by broad occupation and degree field: 1995 (Percentages)

			Degree field (all levels)						
Occupation	Total	Math & computer sciences	Life sciences	Physical sciences	Social sciences	Engineering	Non-S&E		
All scientists and engineers	100.0	14.0	9.3	9.8	12.1	37.5	17.3		
Computer and math scientists	100.0	42.8	2.3	3.9	9.3	15.3	26.3		
Life scientists	100.0	0.5	71.1	6.4	4.7	1.2	16.1		
Physical scientists	100.0	1.8	12.2	73.2	2.7	5.2	5.0		
Social scientists	100.0	0.5	1.1	0.3	79.7	0.5	17.8		
Engineers	100.0	2.4	1.6	4.1	1.6	76.8	13.6		

gree recipients who were employed in non-S&E occupations in 1995 reported that their jobs were closely related to their

degrees, compared to three-fifths of bachelor's degree-holders.

Age Distribution

Age distributions for S&E occupations are affected by historical S&E degree production patterns, net immigration, occupational mobility, morbidity, and mortality. For each degree level and field, the greatest population density occurs during prime productive years—i.e., during the late 30s and throughout the 40s. (See figure 3-4.) This trend reflects the pattern of S&E degree production over the last 50 years—rapid growth with a more recent slowing. Scientists or engineers nearing traditional retirement and high mortality ages are far less numerous than those in the early stages of their careers. This age distribution has several implications for the S&E labor force:

Figure 3-4. Age distribution of employed scientists and engineers, by highest degree received: 1995 Percent 100 Other professional degree Bachelor's Master's All degrees 25 Ph D 20 10 < 25 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60-64 >64 Age group See appendix table 3-6. Science & Engineering Indicators -1998

- ♦ Barring very large reductions in degree production or increases in retirement rates, the number of trained scientists and engineers in the workforce will continue to increase for some time. The number of individuals who are now receiving S&E degrees greatly exceeds the number of S&E-trained workers who are near traditional retirement ages.
- ♦ The number of scientists and engineers reaching traditional retirement ages will increase dramatically over the next 25 years at every degree level.
- ♦ If there is less rapid growth in degree production than in the past, the average age of trained scientists and engineers in the labor force will increase. There are many advantages to having a more experienced S&E labor force. However, in many Ph.D. fields, the greatest productivity in terms of articles published often occurs early in an individual's career.

Sector of Employment

The private for-profit sector is by far the largest employer of S&E workers. In 1995, 72 percent of scientists and engineers with bachelor's degrees and 59 percent of those with master's degrees were employed in a private for-profit company. Academia was the largest sector of employment for those with doctorates (43 percent). Sectors employing smaller numbers of S&E workers include educational institutions other than four-year colleges and universities, non-profit organizations, and state and local government agencies.

Among S&E occupations, there is a wide variation in the proportions of scientists and engineers employed in private for-profit industry. While nearly three-fourths of both computer and math scientists and engineers were employed in this sector, only one-fourth of life scientists and one-fifth of social scientists were so employed in 1995. (See appendix table 3-7.) Educational institutions employed the largest proportions of life scientists (49 percent) and social scientists (44 percent).

Text table 3-13. **S&E degree-holders employed in non-S&E occupations, by relationship of degree to job and highest degree received: 1995**(Percentages)

S&E degree obtained	Takal assaala as	Rela	Relationshop of degree to job		
	Total number in non-S&E occupations	Closely related	Somewhat related	Not related	
All degree-holders	4,690,200	32.6	32.4	35.0	
Bachelor's	3,821,100	29.0	32.9	38.1	
Master's	699,200	48.3	29.8	21.9	
Ph.D	166,500	48.2	34.1	17.6	
Other professional	3,400	71.5	0.0	28.5	

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates, unpublished tabulations.

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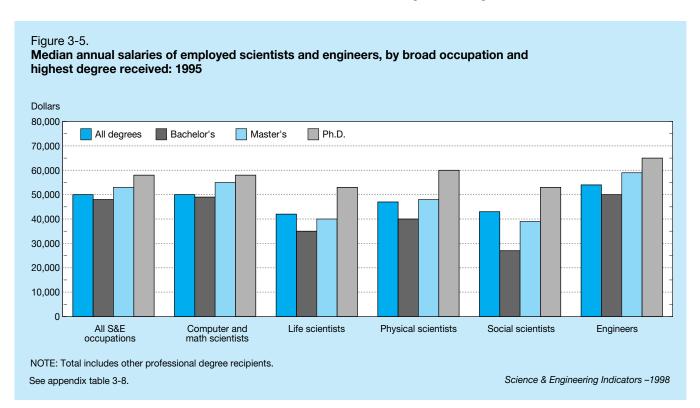
Salaries

Median annual salaries of all S&E workers serve as an excellent indicator of the relative demand for workers in various S&E fields. In 1995, the median annual salary of employed bachelor's degree-holders was \$48,000; for master's recipients, it was \$53,000; and for doctorate-holders, \$58,000. (See figure 3-5.) Engineers commanded the highest salaries at each degree level. The second highest salaries were earned by computer and math scientists at both the bachelor's and master's levels, and physical scientists at the doctorate level. The lowest median salaries were reported for social scientists at each degree level.

Median salaries for scientists and engineers rise steadily with the number of years since degree completion. For example, individuals who earned their bachelor's or master's degrees in the early 1990s earned about \$15,000 less in 1995 than those who received their degrees in the early 1980s (NSF 1995c). For doctorate-holders, the difference is \$18,000. (See text table 3-5 for salary comparisons of those with recent Ph.D.s.)

Women in the S&E Workforce

The U.S. workforce has experienced dramatic changes in its composition during the last half of the 20th century. These changes are attributable in large part to demographic changes stemming from immigration and from birth rates that differ



among racial and ethnic subgroups in the United States. The majority of net new entrants to the workforce are women and minorities. These general trends are also reflected in the S&E workforce.

Employment by Field

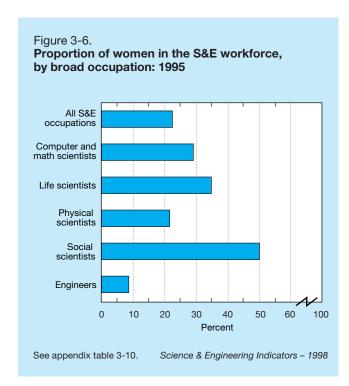
Women comprised a little over 22 percent of the S&E workforce in 1995. (See figure 3-6.) Women are best represented in the social sciences, where they account for one-half of all workers; they are least represented in the physical sciences (22 percent) and engineering (9 percent). Among the science subfields, women are well-represented in biological sciences (40 percent) and in mathematics (33 percent). Within engineering subfields, women are best represented in chemical and industrial engineering (13 percent each) and least represented in aerospace and mechanical engineering (6 percent each).

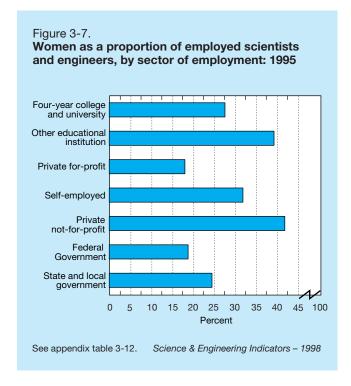
Highest Degree Level

By level of degree, 13 percent of women in S&E occupations report a doctorate as their highest degree—the same proportion as for men. (See appendix table 3-11.) Almost one-third of women report a master's as their highest degree, compared to 27 percent of men. The proportion of women in the S&E workforce is much greater for more recent graduation cohorts at all degree levels. With the exception of computer and math scientists, well over half of the women in each broad S&E occupation at every degree level received their degrees after 1984 (NSF 1995c).

Sector of Employment

Women accounted for 28 percent of the scientists and engineers employed in four-year colleges and universities in 1995



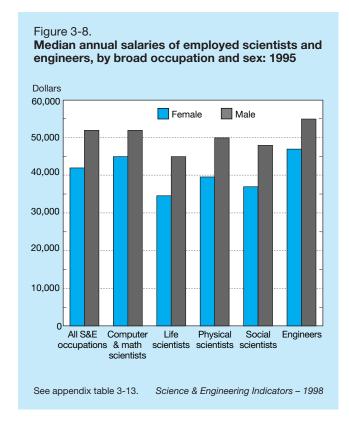


and 39 percent of the S&E workers in other educational institutions. (See figure 3-7.) Only 18 percent of the scientists and engineers in private industry were female. However, this sectoral breakout was due to the extensive presence of women in social science occupations—a large proportion of which are jobs in educational institutions. Among the other employment sectors, women represented 42 percent of the S&E workers in private nonprofit organizations and 32 percent of self-employed scientists and engineers.

Sex and Salary

In 1995, the median annual salary for women scientists and engineers was \$42,000—about 20 percent less than the \$52,000 median annual salary for men. (See figure 3-8.) This difference could be influenced by several factors. For example, women were more likely than men to be working in educational institutions, in social science occupations, and in nonmanagerial positions; they also tended to have less experience than men. Among scientists and engineers in the workforce who have held their degrees five years or less, the median annual salary of S&E women was 85 percent that of men (NSF 1995c).

The salary differential varied greatly by field. In mathematics and computer sciences and in engineering occupations in 1995, women's salaries were approximately 14 percent less than men's. There was a 23 percent salary difference in social and life science occupations. Women also reported the highest and lowest median salaries in these occupations: women earned the highest median salary in engineering (\$47,000) and the lowest in the life sciences (\$34,600). (See appendix table 3-13.)



Racial/Ethnic Minorities in the S&E Workforce

Minorities, except for Asians, are a small proportion of employed scientists and engineers in the United States. Asians, who make up 4 percent of the U.S. population (U.S. Bureau of the Census 1997), accounted for 10 percent of all S&E workers in 1995. Blacks and Hispanics made up 3.4 and 2.8 percent of the S&E workforce, respectively, in 1995; yet they represented 12 and 9 percent of the U.S. population. (See text table 3-14.)

Text table 3-14.

Distribution of employed scientists and engineers, by broad occupation and race/ethnicity: 1995 (Percentages)

Occupation Whi	te Black	K Hispani	Asian/ Pacific c Islander	Native American
All scientists				
& engineers 83.	9 3.4	2.8	9.6	0.3
Computer &				
math scientists 82.	7 4.1	2.4	10.6	0.2
Life scientists 84.	.2 3.2	2.8	9.5	0.2
Physical scientists 84.	.8 2.8	2.5	9.6	0.3
Social scientists 87.	.5 5.2	3.1	3.7	0.5
Engineers 83	7 2.6	3.1	10.3	0.3
See appendix table 3-10.	Scienc	ce & Engin	eering Indica	tors – 1998

Employment by Field

Among broad S&E occupations, Asians—84 percent of whom are foreign-born (NSF 1995c)—are the best represented minority group in computer or math sciences, physical sciences, life sciences, and engineering. In each of these occupations, Asians account for around 10 percent.

The underrepresented minorities—blacks, Hispanics, and Native Americans—are more likely to enter the social sciences and least likely to enter the physical sciences. Blacks are the best represented minority group in social science occupations (5 percent). Blacks also account for 4 percent of computer and math scientists. (See appendix table 3-10.)

Highest Degree Level

Proportionately, Asians tend to have higher levels of education than whites or underrepresented minorities. Almost 60 percent of Asians in the S&E workforce have a master's or doctorate degree as their highest degree, compared to about 40 percent for whites and 35 percent for other minority groups. (See appendix table 3-11.)

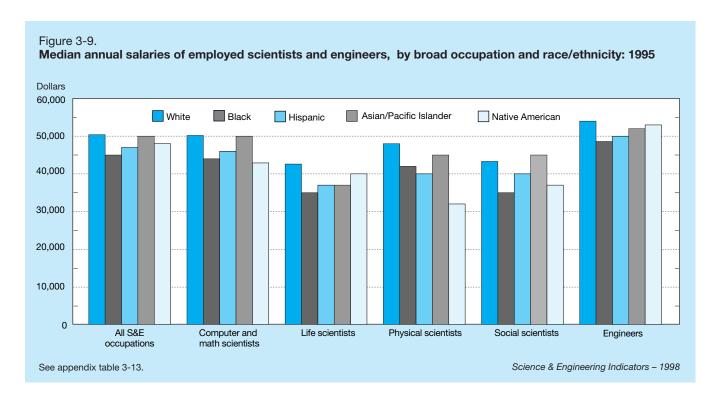
Sector of Employment

Representation of minority groups differs by employment sector. Asians are the best represented minority group in four-year colleges and universities (13 percent), in industry (10 percent), and in the other employment sectors. Blacks are the second best represented minority in the Federal Government (5.4 percent) and in state and local government (5.1 percent). (See appendix table 3-12.)

Salaries

Median annual salaries of Asian scientists and engineers in 1995 did not vary significantly from those of whites (\$50,000 versus \$50,400, respectively). In contrast, the salaries of other minority groups were generally 5 to 10 percent below that of whites. (See figure 3-9.) As with women, the salary difference was mostly due to the greater proportion of minorities in the lower paying social science occupations and to their having fewer years of work experience than whites. However, the salary gap almost disappears with more recent entrants into the S&E workforce (that is, those who received their degree five years ago or less), as the median annual salaries are about the same for all racial/ethnic groups (NSF 1995c).

In 1995, the highest median annual salaries for all racial/ethnic groups were in engineering occupations. Black engineers earned \$48,600; Hispanic engineers, \$50,000; Asian engineers, \$52,000; and Native American engineers, \$53,000. The lowest salaries for blacks were in social and life science occupations (\$35,000); for Native Americans, physical science occupations were the lowest paying (\$32,000); and for Hispanics, it was life science occupations (\$37,000). (See appendix table 3-13.)



S&E Job Patterns in the Service Sector¹³

Although the service sector accounted for only 4 percent of the scientists, 10 percent of the engineers, and 26 percent of the technicians employed in the United States in 1994 (the latest year for which data are available), analysts look to service sector employment as a leading indicator of the health of the S&E labor market, given the economic shift from a manufacturing to a service-oriented base. ¹⁴ The term "service sector" as used here denotes establishments engaged in wholesale and retail trade, transportation, communication, and utilities. Employment of scientists, engineers, and technicians in the service sector increased from 1988 to 1991, then dropped sharply from 1991 to 1994. By 1994, the number of employed scientists and engineers in service industries (185,200) was 8 percent below the 1988 level of 202,000 and 15 percent below the 1991 level of 219,000. ¹⁵ (See text table 3-15.)

Engineering and technician employment was particularly affected by the downturn, as the 1994 total of 129,800 engineers employed in the service sector represented a drop of 11 percent from 1988 and 16 percent from 1991. Technician employment dropped 12 percent over the six-year period. Although employment of scientists dropped 13 percent between 1991 and 1994, the overall decline for the 1988-94 period was negligible.

Principal Employers

As described here, the service sector is divided into three major industry groups: (1) transportation, communications, and utilities; (2) wholesale trade; and (3) retail trade. Within these groups, three industries accounted for 80 percent of total employed scientists and engineers in the service sector in 1994, down from 85 percent in 1988:

- ♦ wholesale trade—durable goods, 31 percent of service sector S&E employment in 1994;
- ♦ utilities (electric, gas, and sanitary services), 29 percent; and
- ♦ communications, 20 percent.

Most of the total sectoral drop in S&E employment between 1988 and 1994 occurred in wholesale trade—durable goods, where 13,500 S&E jobs (19 percent of the industry's 1988 S&E workforce) were lost; and in communications, where 9,000 S&E jobs (20 percent of the industry's 1988 S&E workforce) were lost. (See figure 3-10.)

Partially offsetting the sizable loss in these two industries were gains in wholesale trade—nondurable goods, which provided 2,900 jobs, representing 35 percent of the industry's 1988 S&E workforce; and retail trade, with

¹³Information in this section is from NSF (1997d).

¹⁴Service sector industries are those included in Standard Industrial Classification codes 40-59. Excluded are educational services and state and local governments. Other industries traditionally thought of as "service" industries—such as financial, insurance, real estate, and legal service; entertainment; health services; social services; and hotels and other lodging places—are covered under a separate survey cycle on nonmanufacturing industries; these were last reported on by NSF (forthcoming). Note that the industry groups referred to here as the "service sector" were denoted as "trade and regulated industries" in previous survey cycles.

¹⁵These data are compiled from the Occupational Employment Statistics survey conducted by the U.S. Bureau of Labor Statistics, with support from NSF. (See NSF 1997c.) Until 1996, U.S. business establishments were surveyed once every three years, with roughly one-third of the establishments covered each year. Starting with the 1996 survey cycle (for which data are not yet available), all establishments employing nonfarm wage and salary workers are being surveyed annually.

Text table 3-15.

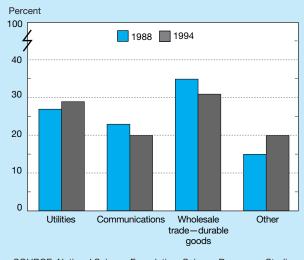
Scientists, engineers, and technicians employed in service sector

Occupation	1988	1991	1994
All scientists, engineers,			
technicians	472,500	477,900	422,700
All scientists & engineers	202,000	219,000	185,200
Scientists	55,500	63,900	55,400
Engineers	146,500	155,100	129,800
Technicians	270,500	258,900	237,500

SOURCE: National Science Foundation, Science Resources Studies Division, "Services Sector S&E Employment Rises, Then Falls Sharply as Engineering and Technician Jobs Are Cut," Data Brief, NSF 97-322 (Arlington, VA: 1997).

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SOURCE: National Science Foundation, Science Resources Studies Division, "Services Sector S&E Employment Rises, Then Falls Sharply as Engineering and Technician Jobs Are Cut," Data Brief, NSF 97-322 (Arlington, VA: 1997).

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3,300 new jobs, representing 34 percent of the industry's 1988 S&E workforce, over the six-year period. In 1994, however, combined total S&E employment in these latter two industries constituted only 13 percent of sectoral S&E employment (3 percent in wholesale trade—nondurable goods and 10 percent in retail trade), which was down from 1991 levels in both industries.

Employment of Scientists

At first glance, scientists might appear to have escaped the decline experienced by their engineer and technician counterparts, as total 1994 employment of 55,400 scientists in the service sector was virtually unchanged from the 1988 figure of 55,500. However, employment of scientists had jumped to 63,900 (an increase of 15 percent) between 1988 and 1991 before falling back in 1994 to the earlier level.

Among service industries employing at least 1,000 scientists in 1991, science employment in all but one declined—often dramatically—between 1991 and 1994. These industries included general merchandise stores and air transportation (both down by 34 percent); trucking and warehousing (down 29 percent); transportation services (down 25 percent); wholesale trade—durable goods (down 20 percent); furniture and home furnishings stores (down 18 percent); wholesale trade—nondurable goods (down 13 percent); miscellaneous retail (down 5 percent); and electric, gas, and sanitary services (down 4 percent). Only in communications was there a 1991-94 increase in employment of scientists (3 percent) (NSF forthcoming).

Employment of Engineers

Of the 19 service sector industries, three accounted for 87 percent of all employed engineers in 1994:

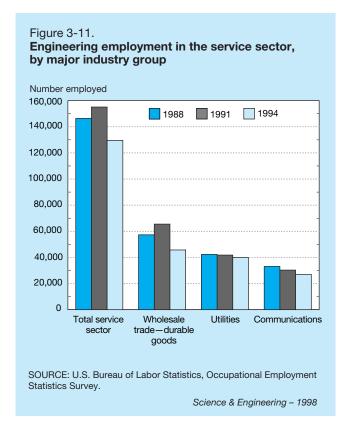
- ♦ wholesale trade—durable goods, 45,700 (35 percent);
- electric, gas, and sanitary services, 39,900 (31 percent); and
- ◆ communications, 27,000 (21 percent).

All three industries suffered declines in engineering employment over the full six-year period 1988-94 and over the shorter 1991-94 period. Wholesale trade—durable goods lost 19,800 engineering jobs between 1991 and 1994 (35 percent of the industry's 1988 engineering workforce and 30 percent of its 1991 engineering workforce). Engineering job losses were more moderate in the other two large service industries. Electric, gas, and sanitary services lost 2,400 (6 percent) of its 42,300 1988 engineering jobs; and communications lost 6,100 (18 percent) of its 33,100 1988 engineering positions. (See figure 3-11.)

Among smaller service industries employing at least 1,000 engineers in 1991, a substantial 1988-94 decline in engineering employment was suffered only by air transportation (a 4 percent decline, but dropping to 33 percent of its 1991 level). All other such service industries either maintained or increased their employment of engineers. Industries employing at least 1,000 engineers and experiencing 1988-94 increases included miscellaneous retail (67 percent), water transportation (60 percent), furniture and home furnishings stores (40 percent), and wholesale trade—nondurable goods (23 percent).

Employment of Technicians

Service sector employment of technicians was dominated by the same three industries as engineering in 1994—and, with 85 percent of this group, almost to the same extent. Wholesale trade—durable goods employed 92,300 (39 percent) of the sector's technicians and experienced the most significant declines—a loss of 10,800 jobs (4 percent) between 1988 and 1991, and an additional 13,400 jobs (13 percent) between 1991 and 1994. The combined loss of 24,200 technician jobs in wholesale trade—durable goods from 1988 to 1994 represented 73 percent of the lost technician jobs in the entire service sector over a six-year period.



Communications, the second largest technician-employing service sector (64,300 jobs, or 27 percent of the sectoral total in 1994) lost 5,200 jobs between 1988 and 1991, but gained 3,000 of these back between 1991 and 1994. Electric, gas, and sanitary services—the third largest employer of technicians in the service sector—lost 5,200 (8 percent) of its 66,500 1988 technician jobs. Like communications, it gained 3,000 of these positions back between 1991 and 1994.

Scientists and Engineers in an International Context: Migration and R&D Employment

Foreign-Born Scientists and Engineers in the United States

In April 1993, 23.0 percent of individuals holding science and engineering doctorates in the United States were foreign-born. ¹⁶ (See text table 3-16.) Of these, 34.1 percent received their S&E doctorates from a foreign school. At the bachelor's degree level, 9.8 percent of those with S&E degrees were foreign-born, with 49.1 percent of degrees from foreign schools.

The relative proportions of foreign-born doctorateholders resident in the United States vary by S&E field. Psychology had the lowest percentage of foreign-born doctorate-holders in 1993 (9.0 percent), and civil engineering had the highest (50.6 percent). In general, the percentage of immigrants was highest in fields with favorable labor market conditions (as measured by unemployment and IOF rates), such as engineering and the computer sciences. It was lowest in the social sciences (except for economics); the life sciences; and the earth, atmospheric, and oceanographic sciences.

In recent years, the number of perm anent visas issued by the U.S. Immigration and Naturalization Service (INS) to immigrants in S&E occupations has been greatly affected by immigration legislation and administrative changes at INS. The 1990 Immigration Act led to increases in the number of employment-based visas available starting in 1992.¹⁷ (See figure 3-12.) Further, the 1992 Chinese Student Protection Act made it possible for Chinese nationals in the United States on student or other temporary

Text table 3-16.

Share of S&E degrees held by foreign-born recipients, by highest degree received: 1993 (Percentages)

l Degree field	Bachelor's degree	Master's/other professional degree	Ph.D. degree
All S&E	. 9.8	18.0	23.0
Life sciences	. 8.0	15.0	21.3
Agricultural sciences	. 5.6	16.0	20.7
Biological sciences	. 9.4	15.5	21.5
Math/computer sciences	. 11.3	21.9	33.6
Computer sciences	. 13.6	29.0	39.4
Mathematics	. 9.2	13.2	31.1
Physical sciences	. 11.3	17.1	25.9
Chemistry	. 14.8	23.6	25.7
Earth, atm. & ocean	. 5.2	9.7	16.8
Physics/astronomy	. 11.2	20.0	30.6
Social sciences		10.1	13.1
Economics	. 11.1	25.5	23.6
Political science	. 6.9	12.4	14.9
Psychology	. 5.9	6.1	9.0
Sociology/anthropology .		13.1	14.4
Engineering	. 13.9	28.4	40.3
Chemical		32.5	38.6
Civil	. 17.3	36.4	50.6
Electrical/electronic	. 14.8	28.6	39.1
Mechanical	. 12.8	30.3	38.1
Non-S&E	. 6.8	7.7	12.4

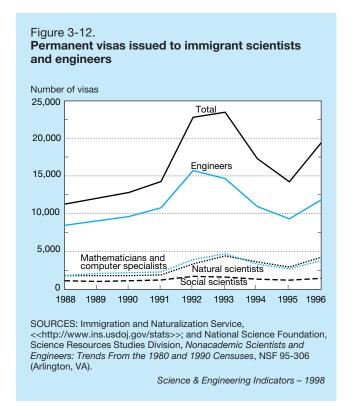
NOTE: Data include all people residing in the United States at the time of the survey with a degree in science and engineering, regardless of where that degree was earned.

SOURCE: National Science Foundation, Science Resources Studies Division, 1993 National Survey of College Graduates.

Science & Engineering Indicators – 1998

¹⁶These estimates are taken from the 1993 National Survey of College Graduates, which, because it samples from decennial census records—rather than, like most surveys of scientists and engineers, from lists of graduates of U.S. schools—will be the best source of data for determining the percentage of scientists and engineers that are foreign born until about 2004.

¹⁷Because many immigrants—including scientists and engineers—enter the United States on family-based visas, where reporting of occupation is optional, S&E occupations might be undercounted.



visas to acquire permanent resident visas. In addition to these legislative acts, changes in procedures for visas led alternatively to surges and backlogs in applications. Aside from these short-term effects, there appears to have been little change in the growth of S&E immigration.

Stay Rates of Foreign Recipients of U.S. Ph.D.s

How many of the foreign students who receive S&E Ph.D.s from U.S. graduate schools stay in the United States? According to a report by Michael Finn (1997) of the Oak Ridge Institute for Science and Education, 47 percent of 1990-91 U.S. S&E doctorate recipients with temporary visas were still in the United States in 1995. 18 By field, this percentage ranged from 28 percent in the social sciences to 53 percent in engineering and the physical sciences. (See text table 3-17.) The overall stay rate for S&E doctoral visa-holders in 1995 was also 47 percent for the 1970-72 cohort. 19 The percentage of this cohort in the United States is stable over time, as 51 percent were in the United States in 1980 as well (Finn 1997). It is quite possible, however, that some of this stability comes from individuals in this cohort reentering the United States in mid-career, replacing others who leave the United States in mid-career. (For more information on this topic, see chapter 2, "Foreign Doctoral Students in the United States." For a

Text table 3-17. Foreign recipients of U.S. Ph.D. degrees residing in the United States in 1995 (Percentages)

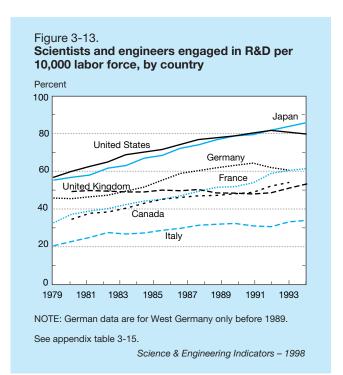
Ph.D. degree field	1990-91 Ph.D.s (temporary visas)	1970-72 Ph.D.s (temporary & permanent visas)
All S&E	47	47
Life sciences	45	36
Physical sciences		
and mathematics	53	57
Social sciences	28	30
Engineering	53	58

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discussion of the obverse phenomenon—emigration of U.S.born Ph.D. recipients—see "How Many U.S. Scientists and Engineers Go Abroad?")

International R&D Employment

Japan continues to surpass the United States in terms of the proportion of the country's labor force comprised of R&Dperforming scientists and engineers. (See figure 3-13.) Both countries lead the remaining G-7 nations (Germany, France, the United Kingdom, Italy, and Canada), although the U.S. share of total G-7 scientists and engineers engaged in R&D has fallen slightly—dropping from 48.0 percent in 1981 to 44.7 percent in 1993. (See figure 3-14.)



¹⁸These estimates were derived by matching records from NSF's Survey of Earned Doctorates to earnings records from the U.S. Social Security Administration. Statistical adjustments for limits to Social Security coverage were made by comparing against coverage rates for native-born doctorate-holders.

¹⁹Data from the NSF Survey of Earned Doctorates do not allow for distinctions between temporary and permanent visas from this period.

How Many U.S. Scientists and Engineers Go Abroad?

In 1995, at least 19,600 U.S. native-born, naturalized citizen, and permanent resident Ph.D. scientists and engineers lived outside the United States.* (See text table 3-18.) These included:

- ♦ 3.3 percent (13,900) of native-born S&E doctorates,
- ♦ 7.4 percent (1,400) of foreign-born S&E doctorates with U.S. citizenship at time of degree, and
- ♦ 13.6 percent (4,300) of permanent residents at time of degree.

Not included are U.S. citizen Ph.D. scientists who had had only a temporary student visa or work visa when they received their Ph.D.; it may be reasonable to assume that this group is as likely to work outside the United States as those who had already been naturalized by the time of degree.

The likelihood of foreign residence for U.S. natives is greatest for those with the most recent degrees—ranging from 2.1 percent of 1945-54 native-born Ph.D. re-

cipients to 3.4 percent of 1985-94 native-born Ph.D. recipients. By field, the proportion of native-born Ph.D.s resident in foreign countries is greatest in the mathematical and computer sciences and in the social sciences (4.2 percent for each). It is lowest in the physical sciences.

*Good estimates of the number of U.S. scientists and engineers who work abroad are not available, and the numbers presented here should be treated as lower bound estimates for several reasons. These estimates are based on a match of administrative data from the NSF 1995 Survey of Doctorate Recipients to individual data from the NSF Doctoral Record File created from the Survey of Earned Doctorates. The National Research Council (NRC) attempted to identify when a nonresponse was due to the sampled individual residing outside the United States as of the April reference date. To the extent that individuals residing outside the United States are more prevalent in the sample portion never located by NRC than they were in the located sample, these numbers will underestimate the extent of emigration. Note that, since a short-term trip abroad would not count as residence, and since the SDR data are collected over several months, there is little danger of miscategorizing a short absence as working abroad. There is, however, a somewhat greater danger of listing a person as living abroad who left the United States for many years and has since returned.

Text table 3-18. Lower bound estimates of U.S. citizen and permanent resident Ph.D. graduates residing outside the United States: 1995

	Na	tive born	citiz	gn-born with zenship at e of Ph.D.	res	rmanent sident at e of Ph.D.	or pe	al citizen ermanent ident at of Ph.D.
Ph.D. degree field	No.	% abroad	No.	% abroad	No.	% abroad	No.	% abroad
All S&E	13,900	3.3	1,400	7.4	4,300	13.6	19,600	4.1
Life sciences	3,400	2.7	200	5.0	900	12.0	4,500	3.3
Math and computer sciences	1,000	4.2	100	4.2	200	10.2	1,200	4.6
Physical sciences	2,200	2.5	300	8.7	800	12.6	3,200	3.3
Social sciences	5,900	4.2	300	7.5	1,200	18.0	7,400	4.9
Engineering	1,500	3.0	500	9.1	1,300	13.1	3,300	5.0

SOURCE: National Science Foundation, Science Resources Studies Division, Doctorate Record File and administrative records associated with collection of the 1995 Survey of Doctorate Recipients.

NOTE: Number and percent abroad data are estimated minimums.

Science & Engineering Indicators - 1998

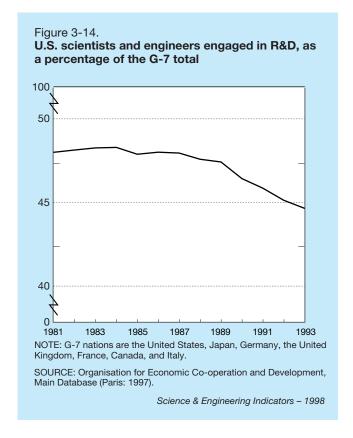
Projected Demand for S&E Workers²⁰

During the 1996-2006 period, employment in S&E occupations is expected to increase at more than three times the rate for all occupations. While the economy as a whole is anticipated to provide approximately 14 percent more jobs over this decade, employment opportunities for S&E jobs are expected to increase by about 44 percent, or about 1.36 million jobs. (See figure 3-15.)

Approximately three-fourths of the increase in S&E jobs

will occur in computer-related occupations. For a discussion of the labor market impacts resulting from the demand for employment in information technology-producing industries, see chapter 8, "IT and Employment." Overall employment in these occupations across all industries is expected to double over the 1996-2006 decade, with over 1 million new jobs being added. Jobs for computer engineers and scientists are expected to increase from 427,000 to 912,000, while employment for computer systems analysts is expected to grow from 506,000 to slightly over 1 million jobs.

²⁰Data in this section are from U.S. BLS (1997).



Within engineering, electrical/electronic engineering is projected to have the biggest absolute and relative employment gains, up by 105,000 jobs, or nearly 29 percent. Civil and mechanical engineers are also expected to experience above average employment gains, with projected increases of about 18 and 16 percent, respectively. Employment for all

engineering occupations is expected to increase by an average of approximately 18 percent.

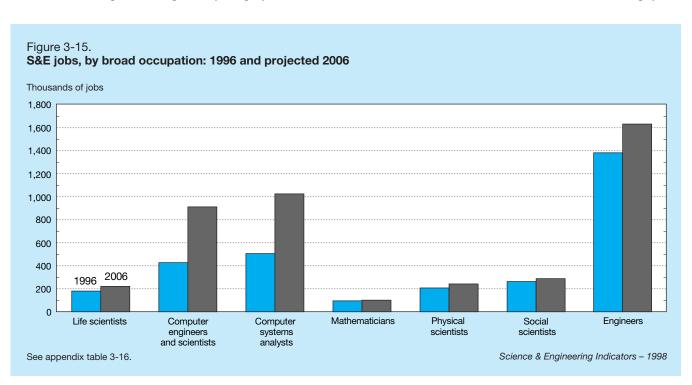
Job opportunities in life science occupations are projected to grow by almost 23 percent (41,000 new jobs) over the 1996-2006 period; at 24 percent, the biological sciences are expected to experience the largest growth (20,000 new jobs). Employment in physical science occupations is expected to increase by about 17 percent, from 207,000 to 242,000 jobs; about half of the projected job gains are for chemists (17,000 new jobs).

Social science occupations are expected to experience below average job growth (10 percent) over the decade, largely due to the modest employment increases anticipated for psychologists (8 percent, or 11,000 new jobs). Economists, however, are projected to experience more favorable job growth (18 percent, or 9,000 new jobs).

Conclusion

There were few changes in labor market conditions for scientists and engineers between 1993 and 1995, the most recent year for which comprehensive data are available. For Ph.D. scientists and engineers, the unemployment rate was essentially unchanged—moving from 1.6 to 1.5 percent. A similarly slight change held for recent S&E Ph.D. recipients, whose unemployment rate went from 1.7 to 1.9 percent and whose IOF rate increased from 4.0 to 4.3 percent. Unemployment rates across all S&E occupations were also low for bachelor's (2.1 percent) and master's (2.5 percent) degree level scientists and engineers.

While the vast majority of new Ph.D. scientists and engineers do find work that is relevant to their training, indicators of labor market difficulties exist in several fields. In physics,



unemployment rates for recent Ph.D.s have dropped to 2.9 percent, but the IOF proportion has increased to 6.7 percent, with placement in tenure-track positions at a historical low. For recent Ph.D. biological scientists, unemployment and IOF rates are low, but so is pay; and the drop in the percentage of tenure-track positions is the greatest of any field. Relative labor market difficulties also exist for recent Ph.D. graduates in political science; mathematics; sociology/anthropology; and the earth, atmospheric, and oceanographic sciences.

While postdoctoral appointments for additional training have become more prevalent over time in most S&E fields, labor market difficulties have stymied their increased use. Exceptions may include both physics—where multiple postdoctorate appointments are becoming more common than in the past—and the earth, atmospheric, and oceanographic sciences—where 29.3 percent of postdoctorates said they took their appointments primarily because other employment was not available.

The future of the S&E labor market is difficult to forecast for any number of practical reasons, but some indicators do exist. On the demand side, the U.S. Bureau of Labor Statistics predicts an increase in S&E jobs of 44 percent between 1996 and 2006—a growth rate three times faster than that for all occupations. The supply of individuals in the labor market with S&E degrees at all levels is likely to continue to increase even if there is no growth in degree production: current graduate numbers are much greater than the number of employed scientists now nearing traditional retirement ages. The same age structure of S&E workers suggests, however, that the number of scientists and engineers retiring will increase dramatically over the next 25 years even if the average retirement age increases.

While changes in earnings and unemployment rates are impossible to predict, on balance these factors suggest a future S&E labor force that is larger and older. Further, this labor force will generally be able to find employment that make use of its training, though not necessarily in tenured academic positions.

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Chapter 4

U.S. and International Research and **Development: Funds and Alliances**

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Highlights

NATIONAL TRENDS IN R&D EXPENDITURES

- ♦ Expenditures on research and development (R&D) performed in the United States reached a record-setting high in 1997, exceeding an estimated \$200 billion for the first time. In addition, the rate of growth in R&D investment in the mid-1990s was the highest it has been since the early 1980s, in contrast to a period earlier in the decade when increases in R&D spending failed to keep pace with inflation.
- ◆ Profit-making companies are responsible for the current upward trend in R&D investment in the United States. The most recent data show industrial firms providing \$2 out of every \$3 (an estimated \$133.3 billion in 1997)—and spending \$3 out of every \$4 (an estimated \$151.4 billion)—invested in R&D in the United States. Both proportions have been edging upward almost continuously for the past quarter century. Increases in the mid-1990s in industrial R&D are the highest recorded since the early 1980s and are largely attributable to record-setting profits, intense international competition, and the introduction of new capabilities in information technology. In addition, in many firms, external research funding is growing at a rate faster than internal spending.
- ♦ The Federal Government, which has been steadily losing ground to industry as a national source of R&D funds, provided an estimated \$62.7 billion in R&D support in 1997. Federal R&D funding has fallen almost continuously in real terms for a decade, although the descent seems to have tapered off in the mid-1990s. In 1997, federal agencies provided 30 percent of all monies spent on R&D in the United States, down from 46 percent a decade earlier (at the peak of the defense buildup).
- ♦ The decline in federal R&D funding is reflected in data for each of the R&D-performing sectors—except academia—but is most visible in data showing federal support of industry R&D. In other words, the impact of defense downsizing on R&D performance can be seen most clearly in the industry-reported R&D numbers. In 1997, federal support of industry-performed R&D was an estimated \$20.8 billion, down about \$8 billion from 10 years earlier. Between 1987 and 1997, the federal share of total industry R&D performance declined dramatically—from 32 percent to an unprecedented 14 percent. It should be noted that the federal share of the industry total has been shrinking almost continuously since at least 1970, because industry's own funding has either outpaced or has not declined as rapidly as federal support.

- ♦ Academia is the only R&D-performing sector that did not experience a cutback in federal support during the 1990s. The annual rate of growth in federal support, however, has been falling fairly steadily for more than a decade, e.g., little real growth is expected for 1995-97. The growth-rate decline can be attributed to efforts to balance the budget and reduce the deficit.
- ♦ All three categories of R&D funding—basic research, applied research, and development—contributed to the overall growth in R&D spending in the United States in the mid-1990s: all three are at their highest levels ever recorded, in both current and constant dollars. All of the growth, however, took place in the private sector. In terms of R&D financial support, the Federal Government's share of total funding for each of the three categories dropped between 1987 and 1997, with particularly severe declines for applied R&D.
- ♦ The nonmanufacturing sector now accounts for approximately one-fourth of all industrial R&D investment in the United States; this is considerably greater than in earlier decades. This higher profile is largely attributable to the growth of the information technology (especially software) and biotechnology industries. Firms in these two categories could seem to be taking over the annual list of the 100 largest R&D-performing companies.
- ♦ Among the six largest R&D-performing manufacturing industries, companies classified in the electrical equipment industry exhibited both the largest absolute increase (\$8.2 billion) and the highest percentage increase (92 percent) in nonfederal R&D expenditures between 1991 and 1995. The additional electrical equipment industry monies appear in the electronic components segment, which accounted for 56 percent of R&D dollars in that industry in 1995 and experienced a three-fold increase in R&D spending between 1991 and 1995.
- ♦ Pharmaceutical companies' R&D spending nearly tripled between 1985 and 1995. The most prominent trend in the drugs and medicines industry has been the melding of pharmaceutical and biotechnology research: e.g., more than one-third of drug companies' R&D projects are primarily biotechnology-related. In addition, the rapid growth of R&D dollars reflects the high cost of research directed at the discovery of cures and treatments for diseases like AIDS, other viruses, and drug-resistant bacteria.
- ♦ Total federal R&D obligations were an estimated \$68.1 billion in fiscal year 1997, 12 percent below the 1989 level (in real dollars), the peak year of federal R&D investment. Defense downsizing, which affected programs at both the Departments of Defense (DOD) and Energy, fueled the overall decline.

- ♦ For the first time since 1981, DOD is expected to account for less than half (48 percent) of the federal R&D total. The DOD share of federal R&D spending has been declining steadily since the mid-1980s. In 1986, at the height of the defense buildup, it accounted for approximately two-thirds of the total.
- ♦ Cooperative R&D is now an important tool in the development and leveraging of science and technology (S&T) resources. There has been a major upswing in the number of inter- and intra-sector and international S&T partnerships since the early 1980s. For example, the annual number of new research joint ventures has been growing in most years, with the largest increases occurring in 1995 and 1996, bringing the total number of these research collaborations up to 665 by the end of 1996.
- ♦ The increase in research joint ventures may reflect, to some extent, companies' participation in the U.S. Department of Commerce's Advanced Technology Program (ATP). Between 1990 and 1996, more than \$2 billion in public and private funds were invested in 288 ATP projects. ATP funding was cut substantially in 1996.
- ◆ Technology transfer activities became an important mission component of federal laboratories in the late 1980s. Although more than 3,500 new cooperative research and development agreements (CRADAs) were executed between 1992 and 1995, government agencies now seem to be backing away from these collaborative research arrangements. The U.S. Council on Automotive Research—better known as the Clean Car Agreement or the Partnership for a New Generation of Vehicles—executed 32 CRADAs in 1995.
- ◆ The elimination in 1995 of the Technology Reinvestment Project affected DOD's "dual-use" strategy of providing financial support to the private sector to develop and deploy those technologies with likely applications in both the commercial and military sectors. This project was replaced in 1997 by the much smaller Dual-Use Applications Program.

INTERNATIONAL TRENDS IN R&D EXPENDITURES

♦ The United States accounts for roughly 44 percent of the industrial world's R&D investment total and continues to outdistance, by more than 2 to 1, the total research investments made by Japan, the second largest performer. Not only did the United States spend more money on R&D activities in 1995 than any other country, it also spent nearly as much by itself as the rest of the major industrialized "Group of Seven" (G-7) countries combined—Japan, Germany, France, the United Kingdom, Italy, and Canada. However, in terms of nondefense R&D spending, combined expenditures in these six coun-

- tries exceeded nondefense R&D spending in the United States by 18 percent.
- ♦ Total R&D expenditures stagnated or declined in each of the largest R&D-performing countries in the early 1990s, but has since recovered in the United States and Japan. There was a worldwide slowing in R&D spending in both large and small industrialized countries in the early 1990s. In fact, inflation-adjusted R&D spending fell for three consecutive years (1992, 1993, and 1994) in both the United States and Japan. Among the G-7 countries, only the United States and Japan showed an apparent reversal of this trend in 1995, with the total R&D effort rising by 6 percent in both countries (in constant dollars and constant yen, respectively).
- ♦ In the United States, the recovery in total R&D spending and its R&D to gross domestic product (GDP) ratio is the result of increased expenditures on nondefense activities. The U.S. R&D/GDP ratio has inched back up to 2.6 percent in 1997 from its 16-year low of 2.4 percent in 1994. The 1997 nondefense R&D/GDP ratio is estimated at 2.2 percent, a historical high.
- ♦ R&D spending in the Russian Federation and in many of the former communist countries in Europe remains considerably below levels in place before the introduction of market economies. R&D downsizing and restructuring of obsolete, state-owned (generally military-oriented) enterprises are necessary to establish viable commercial and scientific R&D infrastructures in these countries.
- ♦ Worldwide changes in the R&D landscape are presenting governments with unparalleled issues of refocusing purpose and direction in S&T policies. Defense R&D has been substantially reduced not only in the United States, but also in the United Kingdom and France, where the national defense share of the government R&D total has declined from 44 to 41 percent, and from 40 to 29 percent, respectively.
- ♦ Among nondefense functions, U.S. Government R&D spending for health is far greater than for any other activity. From 1990 to 1998, health R&D is expected to grow by 26 percent (in constant dollars) while funding for all other nondefense functions will grow by just 3 percent. Health programs now account for 18 percent of the U.S. federal R&D funding total. The greatest growth is in AIDS-related research.
- ♦ Many countries have put into place fiscal incentives to increase the overall level of R&D spending and to stimulate industrial innovation. Practically all industrialized countries (including the United States) allow industry R&D expenditures to be 100 percent expensed in the year they are incurred, and about half of the countries (including the United States) provide some type of additional R&D tax

credit. From 1990 to 1996, U.S. industry received an estimated \$12 billion through tax credits on incremental research and experimentation expenditures. About 15 states offer additional R&D tax credits.

- ♦ Industrial firms increasingly are using global research partnerships to strengthen core competencies and expand into technology fields critical for maintaining market share. Since 1986, companies worldwide have entered into over 4,000 known multi-firm R&D alliances involving strategic high-technology activities. More than one-third of these alliances were between U.S. firms and European or Japanese firms. Most of the alliances were created to develop and share information technologies.
- ♦ Substantial R&D investments are made by U.S. companies overseas. From 1985 to 1995, U.S. firms' investment in overseas R&D increased three times faster than did company-funded R&D performed domestically (10.1 percent versus 3.4 percent average annual constant-dollar growth). Equivalent to about 6 percent of industry's domestic R&D funding in 1985, overseas R&D now amounts to 12 percent of U.S. industry's on-shore R&D expendi-

- tures. Most (72 percent) of U.S.-funded R&D was performed in Europe—primarily Germany, the United Kingdom, and France. Pharmaceutical companies accounted for the largest industry share (20 percent of U.S. 1995 overseas R&D), which was equivalent to 25 percent of their domestically financed R&D.
- ♦ Substantial R&D investments are made by foreign firms in the United States. From 1987 to 1995, inflation-adjusted R&D growth from majority-owned U.S. affiliates of foreign firms averaged 12.5 percent per year. This growth contrasts favorably with the implied 3 percent average annual rate of increase in U.S. firms' domestic R&D funding. R&D expenditures in the United States by foreign companies are now roughly equivalent to U.S. companies' R&D investment abroad. Germany, Switzerland, the United Kingdom, France, and Japan collectively account for 75 percent of this foreign funding. Foreign-funded research in 1995 was concentrated in drugs and medicines, industrial chemicals, and electrical equipment industries. More than 670 foreign-owned R&D facilities are located in the United States.

Introduction

Chapter Overview

Research and development (R&D) appear to be benefiting from the economic prosperity of the mid-1990s. Businesses are thriving, jobs are being created, and inflation seems to be under control. A recent upswing in R&D spending in the United States is paralleling these and other positive economic trends. The annual level of R&D expenditures is estimated to have reached a record-setting high in 1997, exceeding \$200 billion for the first time. In addition, the rate of growth in R&D investment is the highest it has been since the early 1980s, a welcome contrast to a period in the early 1990s when it failed to keep pace with inflation.

What is driving the recent R&D expansion? It is not the Federal Government, which is continuing to curtail its support of defense-related R&D activities. Instead, almost all of the acceleration is attributable to industrial firms. Simply stated, many firms are reaping record profits, which is creating a profitable climate for investment in innovation.

The invention of new and improved products, processes, and services has a pervasive impact on the quality of life and the standard of living in the United States and other industrialized nations. Although a negligible portion of the world's financial and human resources is invested in R&D, advancements in science and technology (S&T) often deliver huge and crucial payoffs in terms of economic growth and prosperity, national security, and the health and well-being of society.

A number of new trends in U.S. R&D investment have emerged in recent years, including:

- ♦ an increase in R&D performed in the service sector;
- an upsurge in state spending on cooperative technology programs;
- elevated political disharmony over the role of the Federal Government in technology development;
- ♦ a mushrooming of collaborative R&D efforts within and across sectors and with international partners; and
- ◆ rapid growth in global R&D expenditure flows, including the rise in U.S. industry's overseas R&D investment, as well as foreign R&D investment in the United States.

In addition, federal spending priorities have been gradually changing. Pressure to balance the budget, combined with defense downsizing (which began in the late 1980s after the end of the Cold War), is continuing to reshape industrial R&D activity, redefine the mission of federal laboratories, and reduce the growth rate of university research programs.

The purpose of this chapter is to track these and other U.S. and international trends in S&T financial investment.

Chapter Organization

This chapter is divided into five parts. The first, "National Trends in R&D Expenditures," contains information on overall R&D funding trends by source of support, performing sector, and character of work (including national investment in basic research, applied research, and development).

The second part, "R&D Patterns by Sector," takes a closer look at each of the R&D-performing sectors. R&D funding and performance by individual manufacturing and nonmanufacturing industries are examined; also included are

discussions of R&D investment by size of company, R&D intensity, and federal support of industry-performed R&D. Next, the most recent data on federal R&D obligations are examined, including statistics for individual agencies and those classified by character of work. The part concludes with a discussion of federal laboratories' role in national R&D performance.

The third part is devoted to domestic partnerships and alliances within and between sectors. Topics covered include industrial R&D consortia, technology transfer activities, and other federal programs designed to stimulate joint research activities.

International R&D comparisons are examined in the fourth part, beginning with an analysis of absolute levels of total and nondefense spending by country, R&D/gross domestic product (GDP) ratios, patterns of sector-specific funding and performance, and information on the character of R&D work undertaken. Next, considerable detail on governments' R&D focus and priorities is provided, including a summary of recent policy initiatives and fiscal incentives for R&D performance.

The fifth part summarizes the growth of international R&D and technology alliances and the rapid rise in industrial R&D investment flows into and out of the United States.

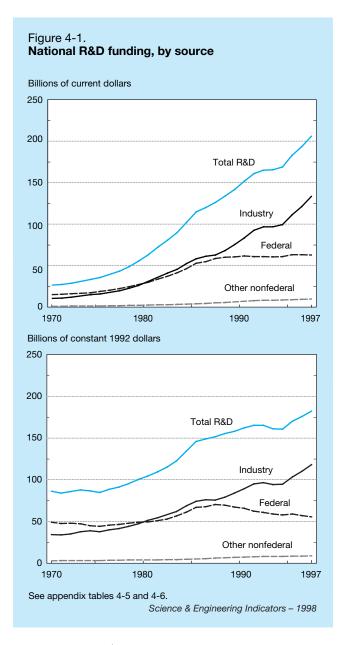
National Trends in R&D Expenditures

R&D investment in the United States hit a record-setting high in 1997, reaching an estimated \$205.7 billion. Total R&D expenditures climbed an average of 4.3 percent per year (in inflation-adjusted dollars) between 1994 and 1997, the highest rate of growth recorded since the early 1980s. In addition, R&D as a percentage of GDP has also been rising. The recent expansion in R&D investment marks a change from the late 1980s and early 1990s when there was relatively little or no real growth in overall R&D spending. (See figure 4-1 and appendix tables 4-3 and 4-4.)

National R&D Trends by Source of Support and Performing Sector

The two major sources of financial support for R&D are industry and the Federal Government, which together supply approximately 95 percent of all funds spent on R&D performed in the United States. The remaining 5 percent is provided primarily by universities and colleges and nonprofit organizations. (See figures 4-1 and 4-2 and appendix table 4-5.)

In addition to financing R&D, industry and the Federal Government are two of the three leading R&D-performing sectors. The third is academia, which is a distant second to industry in terms of R&D performance. In 1997, industry, academia, and the Federal Government were responsible for spending 74 percent, 12 percent, and 8 percent, respectively, of the total dollars invested in R&D in the United States. Two other groups—federally funded research and development

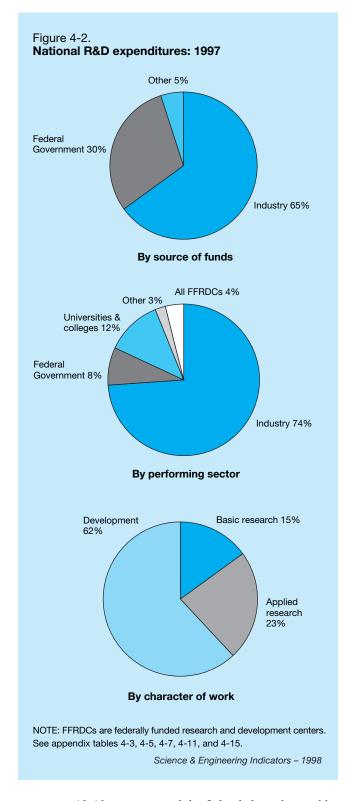


centers (FFRDCs)¹ and nonprofit organizations—accounted for 4 percent and almost 3 percent, respectively.² (See figure 4-2 and appendix table 4-3.)

Industry's share of national R&D performance has been rising steadily—from two-thirds of the total in the 1970s to nearly three-fourths in the late 1990s. During the same period (1970-97), the academic share rose slightly—from 9-10

¹FFRDCs are organizations exclusively or substantially financed by the Federal Government to meet particular requirements or to provide major facilities for research and associated training purposes. Each center is administered by an industrial firm, an individual university, a university consortia, or a nonprofit organization.

²R&D performed by state and local governments is not included in the national R&D totals. In 1995, R&D performance by these entities was estimated to be less than \$400 million. (See "State R&D Issues: High Geographic Concentration and New Data on State Government R&D Support.")



percent to 12-13 percent—and the federal share dropped by half—from 16 percent to 8 percent.

Sources of R&D Support

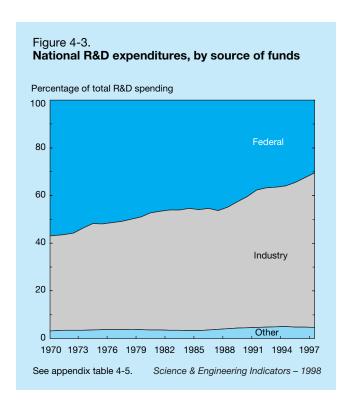
For-profit companies are responsible for the current upswing in R&D investment in the United States. In addition to being both the largest source of R&D funds and the leading R&D-performing sector in the United States, industry also had the highest percentage increase in R&D investment in the mid-1990s.

In 1997, companies provided an estimated \$133.3 billion to finance R&D performed in the United States, or 65 percent of the national total. Nearly all of this amount—\$130.6 billion—was spent on R&D conducted in industrial facilities; the remaining \$2.7 billion was used to support R&D activities undertaken on university and college campuses and at other nonprofit organizations. (See appendix table 4-5 and text table 4-1.)

Industry-Supplied Funding on the Rise. In 1980, industry surpassed the Federal Government as the leading supplier of R&D dollars in the United States. (See figure 4-1.) During the early and mid-1980s, industry's share of the total stood at about 50 percent. Then, in 1987, the proportion of total industry-supplied R&D monies began an almost continuous decade-long climb, with the most recent data showing industrial firms providing \$2 out of every \$3 spent on R&D in the United States. (See figure 4-3.)

Between 1995 and 1997, industry R&D financing grew at an estimated average annual rate of 7.7 percent per year in inflation-adjusted dollars. This trend contrasts with that of the preceding three-year period 1991-94, when no real growth occurred in industry-supplied R&D dollars.

Federal R&D Funding in Decline. While industry's share of the national total was expanding, the federal share was shrinking. In 1997, the Federal Government provided an estimated \$62.7 billion in R&D support, with federal agencies providing 30 percent of all monies spent on R&D in the United States, down from 46 percent a decade earlier (at the peak of the defense buildup). (See figure 4-3.) Federal R&D funding declined almost continuously in real terms between 1987 and



Text table 4-1. **U.S. R&D expenditures, by performing sector and source of funds: 1997** (Millions of U.S. dollars)

			Source of R&D funds				
R&D performer	Total	Industry	Federal Government	Universities and colleges ^a	Other nonprofit institutions	Percent distribution, performers	
Total	205,742	133,308	62,745	6,278	3,411	100.0	
Industry	151,418	130,631	20,787	_	_	73.6	
Industry-administered FFRDCsb	2,273	_	2,273	_	-	1.1	
Federal Government	16,450	_	16,450	_	_	8.0	
Universities and colleges	24,031	1,710	14,285	6,278	1,759	11.7	
University-administered FFRDCs	5,405	_	5,405	_	_	2.6	
Other nonprofit institutions	5,520	967	2,900	_	1,653	2.7	
Nonprofit-administered FFRDCs	644	-	644	-	-	0.3	
Percent distribution, sources	100.0	64.8	30.5	3.1	1.7		

^{- =} unknown, but assumed to be negligible; FFRDCs = federally funded research and development centers

NOTES: Data are estimated. Details may not add up to totals because of rounding.

See appendix table 4-5.

Science & Engineering Indicators - 1998

1997 at an average annual rate of 2.3 percent; the greatest drop occurred during the late 1980s and early 1990s. The descent seems to be tapering off, however, as the annual average decline was estimated to be only 1.3 percent between 1994 and 1997.

Most federal R&D dollars (74 percent) are not used in government-owned laboratories, but rather to finance R&D performed in other sectors. (See figure 4-4 and appendix table 4-5.) For example:

- ♦ Industry received an estimated \$20.8 billion in federal R&D support in 1997 (one-third of all federal R&D monies), mainly to finance defense-related R&D performed under contract to the Departments of Defense (DOD) and Energy (DOE).
- ♦ Academic institutions acquired an estimated \$14.3 billion in federal R&D support in 1997; almost all of the funds supported basic and applied research in the natural sciences and engineering. In addition to the acquisition of new knowledge and breakthrough discoveries, research conducted on university and college campuses provides another widely acknowledged benefit by playing a key role in training the next generation of scientists and engineers. (For more information, see chapters 2 and 5.)
- ◆ FFRDCs and other nonprofit organizations received an estimated \$8.3 billion and \$2.9 billion, respectively, in federal R&D funds in 1997.

Declining Federal Support Felt Most by Industry. The decline in overall federal R&D funding is reflected in data for each of the R&D-performing sectors—except academia—

Figure 4-4. Federal R&D support, by performing sector Billions of constant 1992 dollars 36 32 28 24 Industry 20 Federal Government 16 Universities & colleges 12 Federally funded research and development centers Nonprofits 1987 1989 1991 1993 1995 1997 See appendix table 4-6. Science & Engineering Indicators - 1998

but is most visible in data showing federal support of R&D performed by industry. During the period 1992-97, federal R&D funds supplied to industry are expected to show an average annual decline of 3.8 percent in constant 1992 dollars. Cutbacks in federal intramural and federal support to non-profit organizations are expected to average 1.7 percent, and to all FFRDCs, 2.5 percent in constant 1992 dollars.

alnoludes an estimated \$1.8 billion in state and local government funds provided to university and college performers.

^bFFRDCs conduct R&D almost exclusively for use by the Federal Government. Expenditures for FFRDCs therefore are included in federal R&D support, although some nonfederal R&D support may be included.

In 1987, federal R&D funds accounted for just under one-third of all monies spent by companies to conduct R&D. The most recent data show the shrinking of that proportion down to an unprecedented 14 percent. (It should be noted that the federal share of the industry total has been shrinking almost continuously since at least 1970, because industry's own funding has either outpaced or has not declined as rapidly as federal support.) Although defense downsizing seems to have taken a heavy toll on industry R&D, it is becoming increasingly difficult to track defense R&D flows from federal agencies to industry performers. (See "Accounting for Defense R&D: Discrepancies Between Performer- and Source-Reported Expenditures.")

The curtailment of federal R&D work has had a definite negative effect on overall industrial R&D performance numbers since 1987. That is, the estimated 6.1 percent average annual decline in federal R&D support in constant dollars registered between 1987 and 1997 partially offset growth in industry's own funding during the 10-year period. In 1997, federal support of industry-performed R&D was an estimated \$20.8 billion, down about \$8 billion from the level reported 10 years earlier. (See figure 4-5 and appendix table 4-3.)

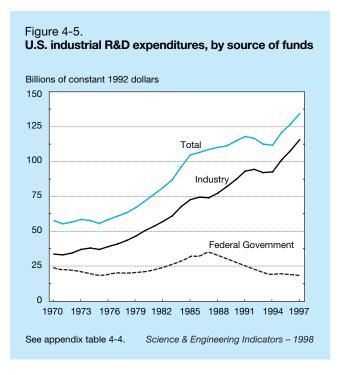
Annual Growth Rate Slowed for Academia. It is important to emphasize that the annual level of federal R&D support to academia has not declined. However, the annual rate of growth in federal support has been falling fairly steadily (in all but two of the past dozen years). The growth rate decline can be attributed to efforts to balance the budget and reduce the deficit. Although academia is the only R&D-performing sector not to have experienced a cutback in federal support during the 1990s, little real growth is expected for 1995-97. While the annual level of total R&D support supplied by each of the five sources that fund academic R&D rose in both current and constant dollars (see appendix tables 4-3 and 4-4), all the sources exhibited 1992-97 growth rates that were about half or less than half of those recorded for the previous five-year period.

Despite the recent slowing, federal support to universities and colleges is estimated to have increased at an average annual constant-dollar rate of 2.3 percent between 1992 and 1997. Industrial support is estimated to have had the largest percentage increase during that period (32 percent), but federal agencies registered the largest absolute increase (\$3 billion) in support of academic R&D.

National R&D Trends by Performing Sector

Industry. In the United States, industry has always been the overwhelming leader in R&D performance. In 1997, three-fourths of the total amount spent on R&D performed in the United States financed work undertaken in industrial laboratories. The total cost of that work is estimated at more than \$150 billion; federal agencies supplied approximately 14 percent of those funds. (See appendix table 4-3.)

A surge in industrial R&D performance during the mid-1990s saw annual expenditure increases estimated at 6.2 percent per year in inflation-adjusted dollars between 1994 and 1997—the highest rate recorded since the early 1980s. The



expansion is entirely attributable to companies' own R&D investment and represents a turnaround from the preceding three-year period when the annual level of industrial R&D outlays failed to keep pace with inflation. (See figure 4-6 and appendix tables 4-3 and 4-4.)

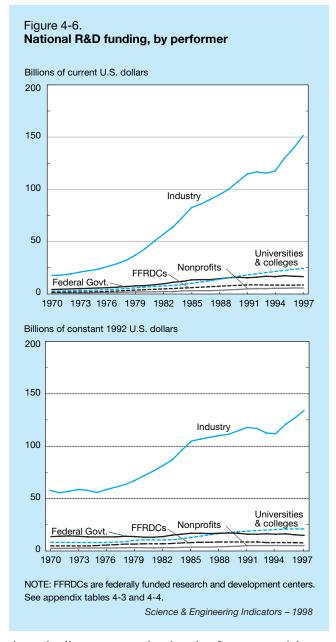
Academia. Academia is a distant second to industry in terms of R&D performance, with total expenditures amounting to an estimated \$24 billion, or 12 percent of the national total. Until 1989, the academic sector ranked third in total R&D performance in the United States, after industry and the Federal Government. Since 1983, however, the annual rate of increase in R&D performed at universities and colleges has been higher than that of the Federal Government (except in 1995). As a result, academic institutions moved into second place in 1989, behind industry. (See figure 4-6 and appendix table 4-3.)

Academia has not suffered a constant-dollar decline in R&D performance in more than two decades. (See appendix table 4-4.) However, the annual real rate of growth has been decreasing almost continuously since 1986, falling from a near 10 percent increase that year to an estimated 1 percent change in both 1996 and 1997.

Most of the research performed on university and college campuses is funded by the Federal Government. In 1997, federal agencies provided an estimated \$14.3 billion, or about 60 percent of the total. Academic institutions supplied an estimated \$4.5 billion of their own funds,³ state and local governments and nonprofit organizations each contributed \$1.8 billion, and industry provided \$1.7 billion.

Federal R&D support to academia has been increasing continuously since 1982, even after adjustment for inflation. Although industry supplies fewer R&D dollars to universi-

³See chapter 5, "Financial Resources for Academic R&D," for an explanation of universities' and colleges' "own funds" and for further discussion of academic R&D expenditure trends.



ties and colleges compared to the other four sources, it has an even longer track record than the Federal Government of continuous growth in the support of academic research—stretching back to at least 1970. As a result, the proportion of academic R&D expenditures supplied by industry has been rising fairly steadily, although industry still represents only a fraction (7 percent) of total academic R&D support.

Federal Agencies. Federal entities spent an estimated \$16.5 billion on intramural R&D in 1997. (Most federal R&D monies are not spent in federally run facilities, but in other sectors.) Federal intramural R&D, as a percentage of total national R&D performance, has been falling fairly steadily since the early 1970s and was down to an estimated 8 percent in 1997.

In real terms, federal intramural R&D is at its lowest point since 1982 because of cutbacks in DOD laboratories; these labs accounted for 56 percent of the intramural total in 1982, but less than half (48 percent) in 1997. The most recent data

show an estimated constant-dollar decline of 9 percent between 1995 and 1997. (See figure 4-6 and appendix table 4-4.)

R&D Support and Performance by Character of Work

The traditional way to analyze trends in R&D performance is to examine the amount of funds devoted to basic research, applied research, and development. (See "Definitions.") These terms are convenient because they correspond to popular models that depict innovation occurring in a straight-line progression through three stages: (1) scientific breakthroughs from

Definitions

The National Science Foundation uses the following definitions in its resource surveys. They have been in place for several decades and are also generally consistent with international definitions.

Basic research. The objective of basic research is to gain more comprehensive knowledge or understanding of the subject under study, without specific applications in mind. In industry, basic research is defined as research that advances scientific knowledge but does not have specific immediate commercial objectives, although it may be in fields of present or potential commercial interest.

Applied research. Applied research is aimed at gaining the knowledge or understanding to meet a specific, recognized need. In industry, applied research includes investigations oriented to discovering new scientific knowledge that has specific commercial objectives with respect to products, processes, or services.

Development. Development is the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes.

Budget authority. Budget authority is the authority provided by federal law to incur financial obligations that will result in outlays.

Obligations. Federal obligations represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when funds were appropriated or payment required.

Outlays. Federal outlays represent the amounts for checks issued and cash payments made during a given period, regardless of when funds were appropriated or obligated.

R&D plant. Federal obligations for R&D plant include the acquisition of, construction of, major repairs to, or alterations in structures, works, equipment, facilities, or land for use in R&D activities at federal or nonfederal installations.

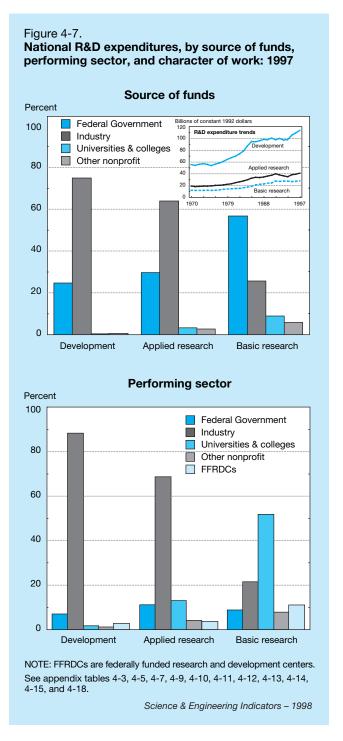
the performance of basic research (2) lead to applied research, which (3) leads to development or application of applied research to commercial products, processes, and services.

The simplicity of this approach makes it appealing to policymakers, even though the traditional categories of basic research, applied research, and development do not always ideally describe the complexity of the relationship between science, technology, and innovation in the real world.⁴

Alternative and perhaps more realistic models of the innovation process have been developed, but they are probably too complicated to be used in collecting and analyzing comparable and reliable data for policymaking purposes, and would not enable time-series analyses. Therefore, the practice of categorizing R&D expenditures into basic research, applied research, and development is unlikely to be abandoned anytime soon.

All three categories of R&D funding contributed to the overall growth in R&D spending in the United States in the mid-1990s, and all three were at their highest levels ever recorded in both current and constant dollars. (See figure 4-7.) All of the gains, however, took place in the private sector. In terms of R&D financial support, the Federal Government's share of total funding for applied research and development dropped dramatically between 1987 and 1997. For applied research, the proportion declined from 38 to 29 percent. The development loss was even more steep, falling from 46 percent of the total to 25 percent. The Federal Government's share of basic research funding also fell during the same 10-year period—from 61 percent of the total to 57 percent. (See figure 4-8.)

Most R&D dollars—an estimated \$128.3 billion in 1997, or 62 percent of the total—are spent on development. Applied research accounted for an estimated 22.5 percent, and basic research for 15 percent. These proportions tend to be fairly stable over time, although percentage point changes usually occur from year to year. For example, basic research's proportion of total R&D varied from 13 to 17 percent during the last quarter century, while applied research and development ranged from 22 to 24 percent, and from 60 to 65 percent, respectively. In the mid-1990s, development increased a couple of percentage points, and basic research fell by about the same amount—probably a reflection of the expanding role



of industry in national R&D performance. Industry performs relatively more development and less basic research than the other sectors.

Basic Research

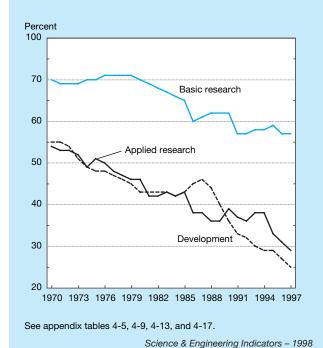
In 1997, an estimated \$31.2 billion was spent on basic research performed in the United States, an increase of about 4 percent in real terms over the 1995 level, and somewhat below the overall R&D increase of 7 percent during the two-year pe-

⁴See NSB (1996), chapter 4, "Alternative Models of R&D and Innovation." In a recent report, the Council on Competitiveness (1996) said "the old distinction between basic and applied research has proven politically unproductive and no longer reflects the realities of the innovation process... The United States [should adopt] a new and more up-to-date vocabulary, one that accounts for changing calculations of R&D risk and relevance over short-, medium- and long-term horizons." In its report, the Council identified three types of research (short-term/low-risk, mid-term/mid-risk, and long-term/high-risk) and the economic sectors that have primary and secondary responsibility for each.

In contrast, another recent study found that R&D managers/directors and financial officials/accountants in both manufacturing and nonmanufacturing firms generally agree that the National Science Foundation's classification of R&D expenditures into basic research, applied research, and development appropriately describes the scope of their companies' self-financed R&D activities (Link 1996a).

Figure 4-8.

The federal share of total U.S. funding of basic research, applied research, and development



riod. Most of that amount—\$17.7 billion, or 57 percent of the total—was supplied by the Federal Government. Industrial firms provided \$8 billion, or 25 percent of the total; universities and colleges, \$2.7 billion; and nonprofit organizations, \$1.7 billion.⁵ (See figure 4-7 and appendix table 4-9.)

Academic Sector Performance. Although the Federal Government is the leading supplier of funds, the academic sector is the largest performer of basic research, with expenditures totaling an estimated \$16 billion in 1997. Of that amount, \$10 billion were federal funds. Far smaller amounts were supplied by the universities themselves, and by state and local governments, industry, and nonprofit organizations. (See appendix table 4-7.)

Financial support for basic research performed in the academic sector is not growing as fast as it did in the late 1980s and early 1990s. The average annual constant-dollar rate of growth was an estimated 2.3 percent between 1992 and 1997, down from the 4.4 percent average registered during the preceding five-year period. All five funding sources contributed to the slowdown, each exhibiting a lower rate during the period 1992-97 than during 1987-92. The drop is particularly noticeable in the largest source of funding—the Federal Government. It is estimated that between 1995 and 1997, federal funding of basic research performed in the academic sector barely kept pace with inflation. (See appendix table 4-10.)

Industry's support of research conducted on university and college campuses has always been a small but growing component of the academic research portfolio. Industry officials have tapped this resource not only to realize the beneficial results of the research they sponsor, but also to capitalize on opportunities to train future scientists and engineers, most of whom will one day be working in their laboratories. Industrial support can take a number of forms, including hiring professors as consultants, funding postdoctoral joint research, and/or providing grants to individual departments (Council on Competitiveness 1996). Although only a small fraction of academic basic research is financed by industry—an estimated 6.5 percent in 1997—companies' support increased an estimated 8 percent in real terms between 1995 and 1997, the largest percentage gain of the five sources that fund academic basic research.7

Increasing use is being made of university research to fill gaps left when industrial basic research is curtailed, e.g., industry and university personnel have been collaborating in areas of military importance, including lasers, electronics, computing, and materials (U.S. DOD 1996). Results from an annual Industrial Research Institute survey confirm that "industry is depending more and more on academic research," e.g., the percentage of respondents anticipating increasing grants for academic R&D rose from 12 percent in 1993 to more than 20 percent in 1996 and 1998 (IRI 1997).

Industrial Performance. Industrial firms spent an estimated \$6.6 billion in company and federal funds on basic research in 1997—about 4 percent of all industrial R&D expenditures. The vast majority of these funds were companies' own financial resources, which increased an estimated 14.5 percent in real terms between 1995 and 1997. (See appendix tables 4-7 and 4-8.)

The gain in industrial investment in basic research estimated for 1995-97 partially offsets a 20 percent decline that took place during the preceding four-year period when several companies' central research facilities were dismantled. That period marked the beginning of a trend toward shorter term R&D and away from fundamental research, largely "driven by the competitive environment and a motivation to extract greater value (or 'effectiveness') from R&D investments" (Larson 1997b). (See "Top 10 'Biggest' Problems for Technology Leaders.") R&D is increasingly being conducted within individual business units in a concerted effort to speed

⁵According to a recent study, only around 2 percent of basic research performed in the United States is supported by foreign sources (Cahners Research 1997).

⁶A recent study revealed that automotive industry officials are more interested in universities' preparation of students than in the usefulness of the research their companies fund. Although they praised the schools for an increased emphasis on manufacturing, they also felt "graduate programs needed to focus more on real-world concerns" (Council on Competitiveness 1996).

⁷Passage of the University and Small Business Patent Procedure Act of 1980, better known as the "Bayh-Dole Act," (see text table 4-8) spurred a major increase in research collaborations between academia and industry.

Top 10 "Biggest" Problems for Technology Leaders

The Industrial Research Institute has been surveying its membership annually since 1993 to identify the biggest problems for technology leaders. (See text table 4-2.) Results from the 1997 survey rank "managing R&D for business growth" first; this issue has increased in relative importance to the Institute's members, who ranked it fourth and fifth in 1996 and 1995, respectively. "Balancing long-term/short-term R&D objectives/focus" was identified as the second most important problem every year of the sur-

Text table 4-2. **Top 10 "biggest" problems for technology leaders**(Percentages of total votes)

vey except 1996 (where it ranked first) and 1993 (third). "Integration of technology planning with business strategy" ranked third in three of the five years. The only item evidencing a noticeable decline in relative importance over the five-year period was "measuring and improving R&D productivity/effectiveness." Until 1996, this item was ranked first in importance; in 1996, it fell to second; and in 1997, it was ranked seventh out of the 10 problem areas.

Survey item	1993	1994	1995	1996	1997
Number of total responses	248	193	258	242	223
Managing R&D for business growth	NA	NA	5.9	10.0	17.0
Balancing long-term/short-term R&D objectives/focus	10.1	12.2	11.0	12.1	14.7
Integration of technology planning with business strategy	11.0	10.2	7.4	11.2	13.0
Making innovation happen	NA	NA	7.8	9.5	10.3
Management of global R&D	3.8	2.9	3.5	4.5	5.8
Leadership of R&D within the corporation	1.7	3.2	2.3	4.2	4.0
Measuring and improving R&D productivity/effectiveness	15.2	15.1	11.5	11.8	4.0
R&D portfolio management	4.2	5.0	4.5	4.5	4.0
Selling R&D internally or externally	5.0	3.1	2.6	4.2	4.0
Information technology	NA	NA	NA	NA	3.1
Percent of responses (top 10)	40.9	39.5	56.5	72.0	79.9

NA = not asked

SOURCE: Industrial Research Institute, Member Company Representatives, "The 'Biggest' Problems Technology Leaders Face," Research Technology Management, September-October, 1997.

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commercialization of new technology. Company research is being "driven largely by business needs rather than curiosity" (Larson 1997b).

In some companies, corporate support for "central research" activity has been eliminated completely. Allied Signal, Armstrong World Industries, and W.R. Grace are recent examples (Larson 1997b). A survey of leading firms found that central corporate funding accounted for about 50 percent of central laboratories' budgets in 1988, but had fallen to about 40 percent in 1993, and that the percentage of cor-

porate funding in the budgets of business unit laboratories decreased from almost 40 percent to less than 10 percent during the same period (Bean 1995). According to another study, increases in outlays for applied research and development have occurred at the expense of basic research (Cahners 1997).

Federal Intramural Performance. An estimated \$2.7 billion was used to finance basic research performed in federally run laboratories in 1997. The annual level of funding has not changed appreciably in real terms since the early 1980s. (See appendix table 4-8.) In addition, basic research as a percentage of total federal intramural research has held constant (at 15 to 16 percent) for the past two decades, indicating that applied research and development—not basic research—have felt the brunt of the general overall decline in federal intramural research.

Applied Research

An estimated \$46.2 billion was spent on applied research performed in the United States in 1997—22.5 percent of the national R&D total. The annual level of investment in applied research increased an estimated 17 percent in real terms between 1994 and 1997, more than offsetting a brief 12 per-

⁸In the late 1980s and early 1990s, U.S. industrial firms were forced to react to a significantly changed climate for R&D financing. Product development was becoming increasingly market- rather than technology-driven, and profit margins were eroding because of escalating international competition and ever-shortening product life cycles. To survive, companies had to cut costs and take a shorter term, more product-oriented approach to R&D. (See "Top 10 'Biggest' Problems for Technology Leaders.") To meet these challenges, many corporate central research laboratories were either eliminated or downsized, and business units took on a more prominent role in performing and funding R&D. In addition, outsourcing R&D to other companies and organizations became a popular way of keeping costs under control. The benefits of these changes are reflected in the enhanced competitiveness of U.S. companies in the mid-1990s. Not only has the conversion of R&D results into new products, processes, and services been accelerated, but the United States has strengthened its position in several critical technologies in which it had been slipping (Council on Competitiveness 1996).

cent downward slide that occurred during the preceding threeyear period. (See figure 4-7 and appendix table 4-12.)

Industry, which led the growth in investment in applied research in the mid-1990s, is both the leading supporter and performer of this type of research. (See figure 4-7 and appendix table 4-13.) In 1997, companies were the source of an estimated \$29.4 billion spent on applied research undertaken in the United States, up 36 percent in real terms over the 1994 level. In general, the proportion of all applied research funds originating in industry has been increasing steadily—up from 42 percent of the national total in 1970 to 64 percent estimated for 1997. Industry's *performance* of applied research was at an all-time high in 1997, an estimated \$31.7 billion (in current dollars), or 69 percent of the national total.

The industrial increase in applied research performance is noteworthy on two counts. First, it represents a major turnaround from the early 1990s when, between 1991 and 1994, the annual number of dollars invested in applied research conducted in industrial laboratories dropped more than \$1 billion per year. Second, it is entirely attributable to companies' own investment. After a series of hefty increases in federal funding of industry-performed applied research in the early 1980s, the level fell each year between 1985 and 1988, recovering in the late 1980s only to decline again in the 1990s. In 1997, federal support of industry-performed applied research was just over half the level recorded seven years earlier. (See appendix table 4-11.)

While industry financing of applied research was recovering from an early 1990s slump, federal funding continued to slide downward, falling an estimated 12 percent in real terms between 1993 and 1997. The Federal Government's share of the total has been declining since 1970, falling from 54 percent that year to an estimated 29 percent in 1997. The decline was particularly steep during the recent period 1994-97, with a drop of 9 percentage points.

Between 1994 and 1997, a major disparity marked trends occurring among the three leading R&D-performing sectors. While the annual level of spending on applied research undertaken in industrial laboratories rose a healthy 28 percent in constant 1992 dollars, the amount spent by academic institutions increased by a modest 5 percent, and the Federal Government's intramural performance was off by about 6 percent. (See appendix table 4-12.)

The annual level of federal investment in intramural applied research held steady in the mid-1990s at approximately \$5 billion; therefore, only a slight reduction in real dollars took place between 1994 and 1997. In contrast, during the preceding six-year period, federal intramural applied research outlays increased an average of 3.4 percent per year in constant dollars. (See appendix tables 4-11 and 4-12.)

Development

Six out of every 10 dollars spent on R&D in the United States are spent on development. (See figure 4-7 and appendix tables 4-3 and 4-15.) An estimated \$128.3 billion was used to finance the development of new and improved products, processes, and services in 1997. This amount exceeds

the 1995 level by about 8 percent, after adjustment for inflation. Development funding has been increasing in real terms since 1993, offsetting sluggish growth in the late 1980s and a brief downward trend in the early 1990s which reflected defense spending cutbacks following the end of the Cold War. Federal support of development projects has been falling in real terms since 1987 at an average annual rate of 4.5 percent, although the rate of decline slowed in the most recent years. In contrast, industry financing increased 5.1 percent per year during the decade. (See appendix table 4-18.)

As with applied research, industry is both the leading provider of development funds and the major performer. Industry became the largest source of development funds in 1974, overtaking the Federal Government that year. Because the advancing and applying of new technologies are activities undertaken almost exclusively in the private, for-profit sector, almost all development dollars (nearly 90 percent) are spent by industrial firms. In 1997, industrial firms were the source of an estimated \$95.9 billion, or about 75 percent, of the total spent on development in the United States. All but \$313 million of these funds were spent in industrial laboratories. The federally provided share of development funds is now estimated to be 25 percent of the total, down from more than 40 percent during the late 1970s and 1980s. (See figure 4-8 and appendix table 4-17.)

Of the estimated \$113 billion spent by industry on development in 1997, an estimated \$17.5 billion, or 15 percent of the total, came from federal contracts. Since 1987, a major curtailment in the annual level of federal funding was reported by industry, with a 27 percent (47 percent after adjustment for inflation) drop being registered between 1987 and 1997. (See appendix tables 4-15 and 4-16.) The most recent data show the other R&D-performing sectors—including the Federal Government, universities and colleges, nonprofit organizations, and FFRDCs—responsible for spending only 12 percent of the national total.

As development R&D *performers*, federal agencies spent an estimated \$8.7 billion in 1997, placing the Federal Government a distant second to industry in terms of development performance. The most recent data show the annual level at about \$1 billion below the 1990 level. In real terms, federal intramural performance of development fell at an average annual rate of 3.7 percent between 1989 and 1997.

R&D Patterns by Sector

In this part, industry and Federal Government investment in R&D is examined in greater detail. See chapter 5 for additional information pertaining to R&D performance in the academic sector.

Industrial Research and Development

Industry is, by far, the largest R&D-performing sector. In 1997, for-profit companies spent an estimated \$130.6 billion of their own (and other nonfederal) funds and \$20.8 billion in federal funds on R&D performed in U.S. industrial labs.

(See figure 4-6 and appendix table 4-3.) In addition, an estimated \$2.3 billion in federal funds were spent on R&D performed at FFRDCs administered by industrial firms.

Mid-1990s Expansion. Between 1993 and 1997, companies' own spending grew at an average annual rate of 5.8 percent in inflation-adjusted dollars. This mid-1990s expansion in industrial R&D activity is largely attributable to international competition; sustained, record-setting profitability; and the introduction of new capabilities in information technology. In addition, in many firms, external research funding is growing at a rate faster than internal spending (Larson 1997b). (See "External Sources of Technology Gaining in Popularity.") The most recent National Science Foundation (NSF) data show a 43 percent increase in company R&D funds contracted to outside organizations between 1994 and 1995 (NSF 1997a).

The recent upswing presents a sharp contrast to the preceding two-year period when R&D financing was relatively flat. In addition, the 1993-97 increase exceeds the 4.2 percent average annual gain recorded between 1985 and 1991.

Federal Government Share at All-Time Low. There was a time (30 years ago) when the Federal Government contributed more than half the total amount of funds spent by indus-

try on R&D activities. Although those days are long gone, government funding did account for one-fourth to one-third of all industry R&D spending as recently as the late 1980s. (See figure 4-5.) The most recent data, however, show that proportion, at 14 percent, to be the lowest it has ever been—12 percentage points below what it was in 1989. Between 1987 and 1997, federal funding of industry-performed R&D fell at an average annual constant-dollar rate of 6.1 percent. However, the descent seems to be slowing: the estimated average yearly rate of decline for 1994-97 is less than it was earlier in the decade. (See appendix table 4-4.)

R&D in Manufacturing Versus Nonmanufacturing Industries

Probably the most striking change in industrial R&D performance during the past decade is the service sector's increased prominence. Until the late 1980s, little attention was paid to R&D conducted by nonmanufacturing companies, largely because service sector R&D activity was negligible compared to the R&D operations of companies classified in manufacturing industries.

External Sources of Technology Gaining in Popularity

There are a number of ways companies can access external sources of technology, including:

- outright acquisition,
- ♦ exclusive license,
- ♦ joint venture,
- ♦ minority equity,
- option for future license,
- ♦ joint development,
- ♦ R&D contract, and
- ♦ exploratory research funding (Chatterji 1996).

Although data on the number and value of these activities are largely unavailable, considerable anecdotal evidence indicates that outsourcing R&D is increasing. For example, aircraft manufacturers are outsourcing more of their R&D to their suppliers, subcontractors, and even customers;* they are also actively involved in joint ventures with their European counterparts (Council on Competitiveness 1996).

A number of factors make external sources of technology increasingly attractive. On the demand side are the following:

- Increased global competition has meant shorter product life cycles and faster development cycle time. To keep up with the accelerating pace of innovation, companies are increasingly having to look beyond their doors to gain access to new sources of technology.
- Downsized companies that handed out pink slips to many of their R&D professionals to reduce costs now find themselves without all the technical expertise they need.
- Collaboration enables participating companies to reduce their risks in exploring promising but highly speculative new technologies.
- Recent success stories have generated more interest in collaboration.

On the supply side, the following factors apply:

- ◆ The worldwide growth of scientific and engineering knowledge has created new, valuable—and available information sources.
- ◆ The availability of venture capital has spurred the formation of startup companies in several high-tech areas, including biotechnology, electronics, and software, that are attractive sources of new technology.
- There is a growing workforce of technical professionals displaced by downsizing; their former employers and other organizations are eager to take advantage of their expertise and experience.

^{*}Boeing outsourced a significant amount of R&D connected with the development of its 777 airliner, including relying on foreign firms (the Japan Aircraft Development Corporation and other firms from Asia, Europe, and Canada) for design and manufacturing expertise (Council on Competitiveness 1996).

Increase in Service Sector R&D. Prior to 1983, non-manufacturing industries accounted for less than 5 percent of the industry R&D total. A decade later, the R&D land-scape looked very different because of a ninefold increase in service sector R&D. The proportion of total industrial R&D performed by companies classified in service industries reached 26 percent in 1993 and then decreased a couple of percentage points in 1994 and 1995. (See chapter 6, figure 6-15.)

In 1995, nonmanufacturing firms' R&D outlays totaled \$32 billion—\$27.4 billion in funds provided by companies and other nonfederal sources, and \$4.6 billion in federal funds. (See appendix table 4-19.) Data for 1991-95 show the R&D expenditures of companies classified in the service sector increasing at about the same pace as in manufacturing companies (which accounts for the 2-point decline mentioned in the preceding paragraph).

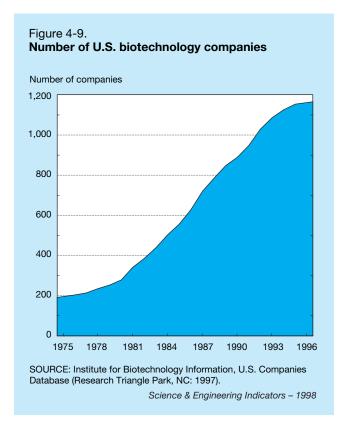
Four industry groupings account for 90 percent of the nonfederal R&D performed in the service sector:

- computer programming, data processing, other computerrelated engineering, architectural, and surveying services accounted for \$9.6 billion in nonfederal R&D expenditures in 1995;
- ♦ wholesale/retail trade, \$7.5 billion;
- ♦ communications services, \$4.8 billion; and
- ♦ research, development, and testing services, \$2.8 billion.

It is likely that companies formerly classified in manufacturing industries account for a sizable portion of the R&D dollars in these service sector categories (especially the top three). For example, given the growing importance of computer software (relative to hardware) and other information technologies, a classification shift from manufacturing to nonmanufacturing would not be unusual.

In addition, because the United States invests a relatively large share of its resources in health care—13.6 percent of GDP in 1995 (U.S. HHS 1996)—the increasing importance of R&D laboratories in the nation's industrial R&D portfolio is also predictable. This greater prominence can be attributed, in large part, to major advances in research on the human body, the establishment and growth of a variety of medical research facilities, and the maturing and success of the biotechnology industry. For example, between 1975 and 1996, nearly 1,000 biotechnology companies came into existence. (See figure 4-9.) Many of these companies are classified in the research, development, and testing services category.

The nonmanufacturing categories also contain a significant number of small startup firms. Some of these are spinoffs from academic research—which is how many software and biotechnology companies came into being (Council on Competitiveness 1996).



Manufacturing Sector. As service sector R&D became more visible, manufacturing R&D lost some of its prominence. Nevertheless, the manufacturing sector continues to dominate industrial R&D. (See text table 4-3.)

In 1995, the six largest manufacturing industries—in terms of companies' own (and other nonfederal) R&D expenditures in the United States were:

Text table 4-3.

Share of total company and other nonfederal funds, by selected R&D-performing industries (Percentages)

	1987	1991	1995
All manufacturing industries	91.6	74.7	74.8
Chemicals and allied products	15.4	15.9	16.0
Petroleum refining and extraction	3.1	2.7	1.6
Machinery	17.2	15.1	8.9
Electrical equipment	17.0	9.8	15.7
Transportation equipment	21.9	16.4	17.8
Instruments	8.1	7.6	7.8
All nonmanufacturing industries	8.4	25.3	25.2
Communication services	1.8	4.6	4.4
Wholesale/retail trade	NA	NA	6.9
Computer programming and			
other related services	3.6	3.6	8.8
Research, development, and			
testing services	0.1	NA	2.6

NA = not available

See appendix table 4-21.

⁹In addition to 1,165 "pure" biotechnology companies (the vast majority of which came into being between 1975 and 1996), the Institute for Biotechnology Information counts 234 (including 56 instrument, 48 pharmaceutical, 32 chemical, 28 agricultural, 22 diagnostic, 20 food, 13 waste and environmental, and 15 in other categories) companies that also conduct biotechnology research.

- ♦ transportation equipment, \$19.3 billion;
- chemicals and allied products (which includes the drugs and medicines industry), \$17.3 billion;
- ♦ electrical equipment, \$17.1 billion;
- machinery (which includes companies classified as computer hardware manufacturers), \$9.7 billion;
- ◆ professional and scientific instruments, \$8.5 billion; and
- ◆ petroleum refining and extraction, \$1.8 billion.

These six industries accounted for 91 percent of all nonfederal R&D funds spent by companies classified in manufacturing industries in 1995, the same percentage they have held since at least 1985. What has changed is their share of all industrial R&D dollars. That proportion fell from over four-fifths of the total in 1987 to two-thirds in 1991, where it has remained. (See appendix table 4-21 and text table 4-3.)

Among the six industries, companies classified in the electrical equipment industry exhibited both the largest absolute increase (\$8.2 billion) and the highest percentage increase (92 percent) in nonfederal R&D expenditures between 1991 and 1995. Text table 4-3 shows a flip-flopping in proportionate share of the total for the electrical equipment and machinery industries between 1991 and 1995, with the latter losing 29 percent of its nonfederal R&D monies. (All of the cutback was in the computer segment of the industry.)

It is probably safe to assume that some part of the machinery industry's decline is attributable to a reclassification of companies into other manufacturing (e.g., electrical equipment) and nonmanufacturing (software) industries, although this scenario cannot be confirmed. ¹⁰ Likewise, the electrical equipment industry's increase may reflect some movement of companies into that industry rather than real gains in R&D investment. However, further study of NSF survey data indicates that a sizable portion of the growth is real (NSF 1998c).

All of the additional electrical equipment industry monies appear in the electronic components segment, which accounted for 56 percent of that industry's 1995 R&D dollars and whose R&D spending increased threefold between 1991 and 1995. Until 1993, the communications equipment segment was the largest component of the electrical equipment industry in terms of R&D. But in 1995, that segment's R&D expenditures were less than half those of electronic components companies; undoubtedly, some of the communications equipment decline reflects a reclassification of those firms into the nonmanufacturing communication services category. (See appendix table 4-21.)

In the largest R&D-performing industry—transportation equipment—a 7.9 percent average annual increase (in inflation-adjusted dollars) in R&D outlays by companies classified in the motor vehicles subgroup was somewhat offset by a 2.7 percent average annual decline in the aircraft and missiles segment between 1991 and 1995. ¹² The 1991-95 increase in automakers' R&D financing represents a major acceleration in R&D investment by that industry, compared to the preceding six-year period. (See appendix table 4-21.)

It is no secret that U.S. companies' share of the world market for motor vehicles declined during the last quarter century; however, the industry has rebounded in recent years. The success and strength of foreign competitors actually led to a "revolution" of sorts in U.S. laboratories and production facilities. R&D has played a major role in the changes, in terms of both the automobile production process and the product itself. The overriding goal of the changes has been to reduce production costs and time-to-market. Success is evident: where it once took five or more years for a new car to go from drawing board to showroom, it now takes only two to three years (Council on Competitiveness 1996).

Two of the largest R&D-performing industries—petroleum refining and extraction, and chemicals (excluding drugs and medicines)—did not contribute to the overall growth in nonfederal industrial R&D expenditures between 1991 and 1995.¹⁴ Companies in these two industry classifications reported cutbacks of 29 percent and 5 percent, respectively, in their R&D financing during the period. (See appendix table 4-21.) R&D downsizing is reflected in oil and chemical companies' drop in ranking in *Inside R&D*'s annual list of the top 100 R&D performers in the United States. (See appendix table 4-23.) It is possible that at least some of the decline in inhouse R&D reported by companies in these two industries is being offset by their increasing participation in industrial R&D consortia. (See "Industrial R&D Consortia.") Chemicals and petroleum companies are some of the most active members of research joint ventures (RJVs), especially those devoted to environmental R&D (Link 1996b).

¹⁰The R&D cutback by computer hardware firms also reflects the industrywide trend of pulling back on central laboratory research to concentrate R&D resources on the development of new products for the market-place (Council on Competitiveness 1996).

¹¹According to the Council on Competitiveness (1996), "semiconductors, opto-electronics, and flat panel displays (FPD) are the three critical building blocks of electronics systems expected to drive U.S. competitiveness in electronics markets over the next several decades." Although the United States regained the lead in the global semiconductor market in 1992, Japan is still out-distancing the United States in FPD technology, opto-electronics, and photo-lithography.

¹²U.S. firms are no longer the sole players in the world's commercial aircraft market. In addition to the entry of Airbus Industrie Groupe (a consortium sponsored by the German, French, British, and Spanish governments), other nations (including Japan, China, Russia, and Taiwan) have announced their intentions to enter the commercial aircraft market (Council on Competitiveness 1996).

¹³For example, all U.S. firms have adopted Japanese manufacturing practices such as concurrent engineering. In addition, various computer and information technologies have improved and accelerated the design, development, and production of motor vehicles. Computer-based technologies have also played a major role on the product side, i.e., electronic systems have revolutionized the way vehicles are operated. In large part, these new capabilities reflect manufacturers' compliance with government regulations. Meeting standards for mileage, emissions, and safety has played a major role in shaping manufacturers' research agendas (Council on Competitiveness1996).

¹⁴According to chemicals industry officials, long-term R&D—i.e., the development of new processes and products—has been sacrificed in favor of seeking incremental improvements for existing products. Until the 1980s, one-third to one-half of R&D expenditures in the industry went to new processes and products; that proportion is now down to less than one-fourth (Council on Competitiveness 1996).

In contrast to the lackluster R&D performance of industrial chemicals companies, the other part of the chemicals industry, which consists of pharmaceutical companies, had its usual healthy increase in R&D spending: the size of drug companies' R&D programs nearly tripled between 1985 and 1995. (See appendix table 4-21.)

The most prominent recent trend in the drugs and medicines industry has been the melding of pharmaceutical and biotechnology research; more than one-third of drug companies' R&D projects are primarily biotechnology-related. In addition, pharmaceutical companies have been collaborating with and acquiring biotechnology companies to take advantage of the latter's potentially lucrative discoveries. The success and strength of the biotechnology industry is reinforcing the United States's world leadership position in drug research (Council on Competitiveness 1996).

R&D Expenditures by Size of Company

In 1995, 122 companies with more than 25,000 employees spent more than \$1 million each on R&D in the United States (NSF 1998c). Prior to 1990, this group of companies accounted for more than half the nonfederal R&D expenditure total. That share has fallen below 50 percent because the R&D outlays of small and medium-size firms have been increasing faster than those of large companies. For example, small firms (those with fewer than 500 employees) accounted for 14 percent of all nonfederal R&D expenditures in the United States in 1995, up from 10 percent five years earlier. (See appendix table 4-21.)

Industrial R&D Concentrated in Large Firms. Despite small companies' rising share, U.S. industrial R&D expenditures remain heavily concentrated in a relatively small number of relatively large firms. For example, approximately 25 U.S. companies spent more than \$1 billion each on R&D in 1996; 10 years earlier, only 10 companies exceeded the billion-dollar mark (Technical Insights 1997 and 1988). In 1995, the 4 largest R&D-performing companies (in terms of nonfederal funds) accounted for 16 percent of the total amount spent; the 20 largest, 34 percent; and the 200 largest, 68 percent. The last statistic, however, is less than the 80 percent and 82 percent shares held in 1990 and 1985, respectively. (See appendix table 4-24.)

Changes in Rankings of Top 100 R&D Companies. During the 10-year period 1986-96, major membership changes occurred in *Inside R&D*'s annual list of 100 leading R&D-performing companies. (See appendix table 4-23.) The three largest R&D-performing companies, however, were the same in both years, although the second- and third-ranked companies switched places. That constant may be one of few revealed by comparing the lists from 1986 and 1996, as major changes in rankings occurred among the remaining 97 entries:

- ♦ The 5th, 8th, 9th, and 10th largest R&D-performing companies in 1996 were not among the top 10 in 1986. 16 Of these four companies, Intel made the largest leap, going from 46th to 9th place.
- ♦ Computer software and some computer hardware, pharmaceutical, and biotechnology firms are increasingly prominent R&D performers. Companies like Microsoft, Sun Microsystems, Inc., Amgen, Seagate Technology, Genentech, Compaq Computer, and Cisco Systems were not even on the list in 1986 and now rank in the top 50. Microsoft spends more on R&D than all but a dozen U.S. companies.
- ♦ Almost half the companies ranked 50 to 100 are new to the list. Nearly every company in the new group is either a software (e.g., Novell) or a biotechnology (e.g., Genzyme) company.
- ♦ Almost all petroleum and chemical companies fell sharply in rank. For example, Dupont dropped from 6th to 26th place, and Dow Chemical and Monsanto dropped from 15th and 17th, respectively, to 31st and 32nd. The largest oil company, Exxon, was 41st in 1996, compared to 14th 10 years earlier.
- ♦ Aerospace firms also declined in ranking. Boeing and McDonnell Douglas (which merged in 1997) dropped from 11th to 20th and from 19th to 55th, respectively. The combination of Lockheed and Martin Marietta and all the other acquisitions that now comprise a single company (see figure 4-10) kept Lockheed Martin at number 30.

R&D Intensity

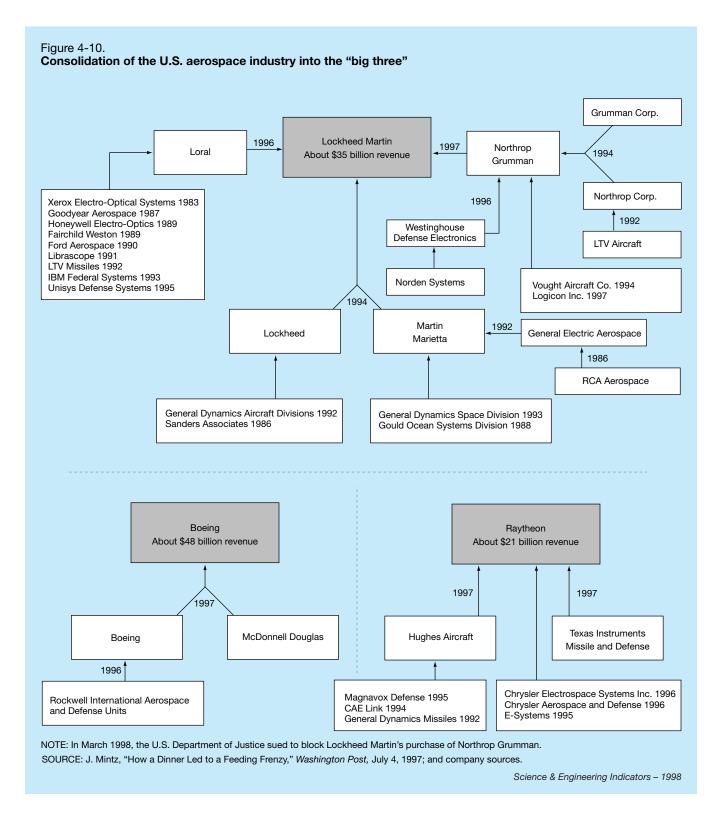
In addition to absolute levels of and changes in R&D expenditures, another key indicator of the health of industrial science and technology is R&D intensity. R&D is similar to sales, marketing, and general management expenses in that it is a discretionary—i.e., non-direct-revenue-producing—item that can be trimmed when profits are falling. There seems to be considerable evidence, however, that R&D enjoys a high degree of immunity from belt-tightening endeavors—even when the economy is faltering—because of its crucial role in laying the foundation for future growth and prosperity.

There are a number of ways to measure R&D intensity, but the one used most frequently is the ratio of R&D funds to net sales. This statistic provides a way to gauge the relative importance of R&D across industries and firms in the same industry.

The ratio of R&D dollars to net sales tends to be fairly stable over time, although year-to-year changes of 0.1 to 0.2 percentage points are not uncommon. Also, there are

¹⁵The rapid growth of R&D dollars in the drug industry reflects the high cost of research directed at discovering cures and treatments for diseases like AIDS, other viruses, and drug-resistant bacteria. In addition, managed competition is changing the way drug companies do business in the health care services marketplace; new constraints on pricing could adversely affect R&D (Council on Competitiveness 1996).

¹⁶Lucent Technologies (ranked sixth in 1996) was split off from ATT in 1996. As a result, Lucent got ATT's top-10 berth on the list, and ATT (ranked 4th in 1986) ranked 36th in 1996. Another company, TRW, restated its R&D expenses reported to the Securities and Exchange Commission in 1996 to include all "sponsor-supported" R&D, which means that federal R&D funds are now included in the company's total. As a result, the company earned the seventh highest spot on the 1996 top-100 list.



substantial differences between industries. (See appendix table 4-25 and text table 4-4.)

In 1994 and 1995, the most recent years for which data are available, nonfederal R&D spending as a percentage of net sales for all R&D-performing companies classified in manufacturing industries was 2.9 percent. This ratio was four-tenths

of a percent less than that recorded for the peak year 1992 and was the first dip below 3.0 percent in 10 years. (See figure 4-11 and appendix table 4-25.) Despite the decline, it is still safe to assume that little change has occurred in the level of importance accorded R&D relative to other discretionary expenditures. That is, roughly the same proportion of compa-

Text table 4-4. Industry segments with the highest and lowest company (and other nonfederal) R&D funds/net sales ratios: 1995 (Percentages)

Industry segment R	&D funds/net sales ratio
Highest ratios	
Drugs and medicines	10.4
Office, computing, and accounting	
machines	8.1
Communication equipment	8.0
Electronic components	8.0
Optical, surgical, photographic,	
and other instruments	8.0
Scientific and mechanical	
measuring instruments	6.6
Aircraft and missiles	4.2
Lowest ratios	
Textiles and apparel	0.9
Lumber, wood products, and furnitu	re 0.7
Petroleum refining and extraction	0.7
Food and tobacco products	0.5
Primary metals	0.5

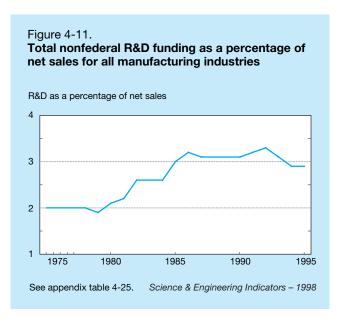
nies' income was devoted to R&D throughout the late 1980s and early 1990s. ¹⁷ Minor fluctuations indicate that R&D is able to hold its own during recessionary periods such as that experienced in the early 1990s and in periods of recovery when profits are outpacing R&D investment.

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Disparity in R&D Intensity Across Sectors. As previously mentioned, R&D intensity differs significantly across industries. (See text table 4-4.) Individual industry ratios range from a high of 10.4 percent in the pharmaceutical industry to a low of 0.5 percent in the food and primary metals categories. ¹⁸ The pharmaceutical industry has led all other industries since 1993, a reflection of the risky and complex nature of drug research; in 1995, it had the only double-digit ratio. Among the least R&D-intensive industries, only the petroleum industry ranked among the six largest R&D-performing industries.

Federal R&D Funds

In 1997, industrial firms spent an estimated \$20.8 billion in federal funds on R&D activities. As mentioned earlier in this chapter, federal R&D support to industry has been declining almost continuously since 1987.



The aircraft and missiles industry is the leading recipient of federal R&D funds. Interestingly, this industry formerly accounted for more than two-thirds of all federal monies spent by companies; however, the most recent company-reported data (1995) show it accounting for less than one-half of federal funds. (See appendix table 4-22 and "U.S. Aerospace Firms' Declining Government Sales Offset by Growing Civilian Market.")

A spate of mergers and restructurings has taken place in recent years among defense contractors. Like the "big three" automakers, there are now the "big three" aerospace companies. (See figure 4-10.) For more information on industry's defense-related R&D, see "Independent Research and Development Provides Additional Defense Funding."

Patterns of Federal R&D Support

R&D consumes only a fraction—less than 5 percent—of all public expenditures in the United States. (See "R&D Faring Relatively Well Despite Fiscal Austerity.") Despite their lack of prominence within a trillion-dollar budget, R&D funding trends reflect overall national priorities, including the emphasis on deficit reduction and the shifting balance between defense and domestic programs. For example, a reduction in defense-related programs, facilitated by the end of the Cold War, has been partially offset by increases in support for civilian R&D programs—especially those aimed at improving disease diagnosis and treatment, technological competitiveness, and the environment.

Total federal R&D obligations were an estimated \$68.1 billion in fiscal year (FY) 1997, 12 percent below the peak 1989 level (in inflation-adjusted dollars). Defense downsizing, which affected programs at both DOD and DOE, fueled the overall decline. (See appendix table 4-27.)

¹⁷It is important to note that there were significant increases in the overall R&D funds/net sales ratio between 1981 and 1982 (from 2.2 percent to 2.6 percent) and between 1984 and 1986 (from 2.7 percent to 3.2 percent). Prior to 1982, company R&D funds as a percentage of net sales had been in the 2.0 percent range for 20 years.

¹⁸R&D outlays in the semiconductor equipment and materials industry are estimated to be about 12 to 15 percent of sales (Council on Competitiveness 1996). The broad industry classification system used in NSF's industrial R&D survey tends to mask pockets of high-tech activity.

¹⁹An alternative method for measuring federal R&D investment, called the Federal Science and Technology budget, was proposed in 1995 by the National Academy of Sciences. (See "The Federal Science and Technology Budget.")

U.S. Aerospace Firms' Declining Government Sales Offset by Growing Civilian Market

Data from the Aerospace Industries Association (AIA) show sales of aerospace products and services falling from \$116 billion in 1991 to \$90 billion in 1995, then increasing to \$120 billion in 1998 (AIA 1997). The recent increase is attributable to growing sales to commercial customers, although DOD remains the industry's largest single customer. But while DOD used to account for two-thirds of aerospace sales (between 1984 and 1987), it now accounts for slightly more than a third. AIA data show DOD purchases from the aerospace industry declining from \$61.8 billion in 1987 to an estimated \$42.6 billion in 1998.* In 1998, for the first time, all federal agencies together accounted for less than half of all aerospace sales; from 1984 through 1987, they accounted for approximately three-fourths.

Product group data also show the shift from military to civilian customers:

- ♦ Sales of military aircraft fell from \$43.7 billion in 1987 to an estimated \$30.4 billion in 1998. They now account for 25 percent of all aerospace-related sales, down from nearly half in 1987.
- ◆ AIA data show civilian airliner sales surpassing those of military aircraft for the first time in 1997. In 1998, civilian planes and jets are estimated to be 41 percent of all aerospace-related sales, up from only 17 percent in 1987.
- ♦ Annual sales of missiles fell 43 percent in the 1990s—from a peak of \$14.2 billion in 1990 to \$8.0 billion estimated for 1998. As a percentage of all aerospace-related sales, missiles fell from 13 percent in 1990 to 7 percent in 1998.
- ◆ Space sales (now just over a quarter of all aerospacerelated sales) increased steadily between 1982 and 1992, fell slightly between 1992 and 1994, then increased again to \$32.8 billion estimated for 1998.

Independent Research and Development Provides Additional Defense Spending

In addition to the federal R&D obligations discussed in this chapter, DOD's Independent Research and Development (IR&D) Program enables industry to obtain federal funding for R&D conducted in anticipation of government defense and space needs. Because it is initiated by private contractors themselves, IR&D is distinct from R&D performed under contract to government agencies for specific purposes. IR&D allows contractors to recover a portion of their in-house R&D costs through overhead payments on federal contracts on the same basis as general and administrative expenses.

Until 1992, all reimbursable IR&D projects were to have "potential military relevance." Because of the concern that defense cutbacks would reduce civilian R&D—not only in the level of commercial spillovers from weapons research but, more importantly, in reduced DOD procurement from which IR&D is funded—the rules for reimbursement were eased and the eligibility criteria broadened.* Reimbursement is now permissible for a va-

riety of IR&D projects of interest to DOD, including those intended to enhance industrial competitiveness, develop or promote dual-use technologies, or provide technologies for addressing environmental concerns.

In 1996, industrial firms were estimated to have incurred minimally \$3.0 billion in IR&D cost, of which \$2.9 billion was deemed eligible for reimbursement. The government reimbursed \$1.9 billion, or 66 percent of the IR&D total. As a result of the expanded reimbursement eligibility criteria, the amounts reimbursed have held rather steady at about \$2 billion per year since 1984. (See appendix table 4-56.) As an equivalent proportion of combined DOD and National Aeronautics and Space Administration (NASA) industrial R&D support, IR&D fell from 11 percent in 1984 to 7 percent in 1996, although this figure is undoubtedly on the low side as a result of accounting and statistical changes. Previously, contractors with auditable costs of \$40 million or more were included in the IR&D statistics. The current threshold now includes only those firms with auditable costs of more than \$70 million. NASA also reimburses IR&D costs and closely follows DOD procedures. The statistics provided here include reimbursements from NASA. It remains unclear whether changes in the rules governing IR&D have had their intended effect on industrial activity.

^{*}DOD data are a combination of two accounts: (1) procurement and (2) research, development, test, and evaluation.

^{*}See NSB (1991) for a brief description of how reimbursement for IR&D was until recently determined. The National Defense Authorization Act for Fiscal Years 1992 and 1993 (P.L. 102-190) provided for the gradual removal of limitations on the amount DOD will reimburse contractors for IR&D expenditures and partially eliminates the need for advance agreements and technical review of IR&D programs.

The Federal Science and Technology Budget

In a 1995 report (NAS 1995) members of a National Academy of Sciences committee proposed an alternative method of measuring the Federal Government's S&T investment. According to committee members and other policymakers, this new approach—titled the Federal Science and Technology (FS&T) budget—provides a better way to track and evaluate trends in public investment in R&D.

The FS&T budget is actually a subset of what is usually referred to as the federal budget for research and development. Advocates of the new approach contend that the traditional method of counting federal dollars spent on R&D overstates the actual amount of federal R&D investment, because certain items are included that should not be. Although no one discounts the importance of production engineering, testing and evaluation, and upgrade of aircraft and large weapons systems, FS&T budget proponents contend that these activities should not be counted as R&D because they do not involve the discovery of new knowledge or the creation of new technologies. Moreover, they are not "major contributor[s] to economic growth, national security, health, [and] quality of life."

If the FS&T were used instead of the traditional budget to evaluate federal R&D investment, DOD's R&D numbers would look quite different. The \$25 billion in FY 1997 DOD obligations slated for "major systems development" would no longer be considered R&D and therefore would be subtracted from DOD's total R&D obligations of \$33 billion. Doing so would leave \$8.0 billion in the FS&T budget, or \$3.9 billion in DOD-sponsored research and \$4.1 billion in advanced technology development.* In addition, FS&T budget data would show a 9.1 percent decline in DOD R&D obligations between FYs 1994 and 1997—about twice the percentage decline registered when performing a conventional analysis of DOD's R&D investment. (See text table 4-5.)

For all other federal agencies except DOD, the National Academy of Sciences estimates a 3.5 percent increase in the FS&T budget between FYs 1994 and 1996, compared to a 7.4 percent increase using the traditional method.

Text table 4-5.

The FS&T budget for the Department of Defense:
(Millions of current U.S. dollars)

DOD R&D activity	1994	1995	1996	1997	% change 1994-97
Total, FS&T budget	8.8	8.9	8.7	8.0	-9.1
Research	4.3	4.3	3.9	3.9	-9.3
Advanced technology development	4.5	4.6	4.8	4.1	-8.9
Major systems development	25.8	25.4	25.5	25.0	-3.1
Total, traditional federal R&D budget	34.6	34.4	34.3	33.0	-4.6

FS&T = Federal Science and Technology

SOURCES: National Science Foundation, Science Resources Studies Division (NSF/SRS), Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997).

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Reduced DOD Prominence in Federal R&D Portfolio

For the first time since 1981, DOD is expected to account for less than half of total federal R&D obligations. (See figure 4-13.) The DOD share of federal R&D spending has been declining steadily since the mid-1980s.

DOD obligations have fallen in both current and constant dollars every year since 1992. In 1997, they stood at an estimated \$33 billion, down nearly 20 percent in real terms from the 1992 level. (See appendix table 4-27.)

Despite the receding prominence of DOD in the R&D portfolio, the agency still overshadows all other federal

sources of R&D dollars. The Department of Health and Human Services (HHS) is a distant second, with R&D obligations estimated at \$12.2 billion in FY 1997. In contrast to the DOD trend, HHS support has been increasing steadily since 1992, although no real growth is expected between 1996 and 1997. (See figure 4-14.)

Between 1992 and 1997, HHS's R&D obligations rose an estimated average of 3.7 percent per year in real terms, and increased to 18 percent—up from 14 percent—of all federal R&D obligations during the same period. This growth reflects the steady stream of new dollars into almost all of the National Institutes of Health (NIH), which account for 95 percent of HHS R&D obligations.

^{*}DOD's S&T base provides a substantial portion of all federal support for research and generic technology development in several key areas, including computer science, electrical engineering, and materials.

R&D Faring Relatively Well Despite Fiscal Austerity

The President's FY 1998 budget calls for approximately \$1.7 trillion in total government spending. Only 4.3 percent of that amount—about \$72.6 billion—is designated for R&D programs (including R&D plant).

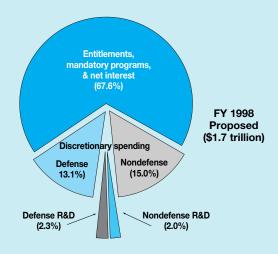
Reducing the deficit has been an overriding goal of both Congress and the Administration. To gain a better understanding of the difficulty involved in accomplishing this objective, it is helpful to split total federal spending into two categories—"mandatory" and "discretionary." Certain program expenditures, including those for Social Security, veterans' benefits, Medicare, Medicaid, and interest on the national debt, are considered mandatory items in the federal budget. That is, the government is already committed by law to financing those programs at certain levels and cannot cut them without serious political repercussions. In contrast, discretionary items, including R&D programs, do not enjoy the same level of protection from budget-cutting proposals; and the Federal Government does not have to, or is not already committed by law to, finance such programs at particular levels.

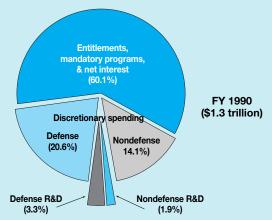
In recent years, the proportion of the federal budget that supports mandatory programs has been expanding while the discretionary share has been shrinking. Mandatory programs are expected to account for more than two-thirds of the total federal budget in 1998—up from less than half prior to 1980. With discretionary programs now comprising less than a third of the total budget, items like R&D and other discretionary programs are becoming increasingly likely candidates for reduction or curtailment to meet deficit-reduction targets.

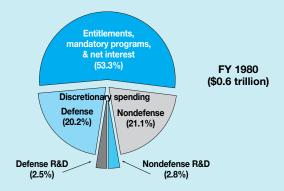
Despite its increasing vulnerability, R&D has actually fared relatively well during the fiscal austerity of the 1990s. (See figure 4-12.) For example, an examination of R&D as a percentage of the total federal budget reveals the following:

- ♦ Although all federally funded R&D is expected to fall from 5.2 percent of the budget in 1990 to 4.3 percent in 1998, nondefense R&D as a percentage of the total budget is expected to remain fairly constant at 2.0 percent during the same period.
- ♦ As a proportion of total discretionary spending, R&D has risen from 11.5 percent in 1980 to 13.0 percent in 1990 to 13.3 percent in 1998.
- ♦ Nondefense R&D as a percentage of nondefense discretionary spending has been holding fairly steady since 1980 at just under 13 percent.

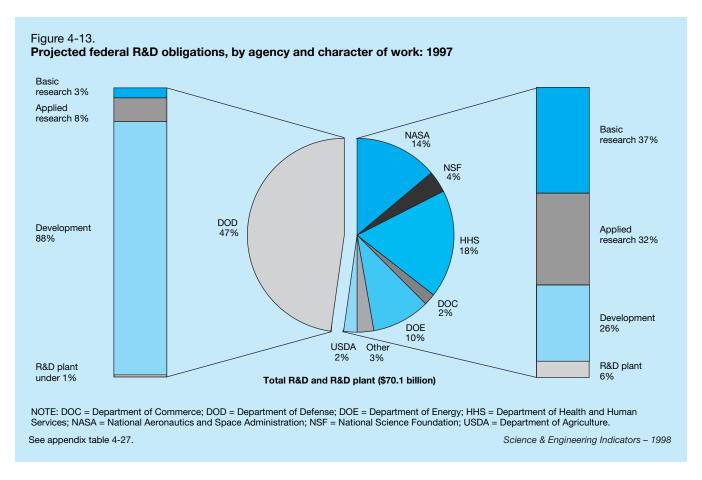
Figure 4-12. **R&D share of the federal budget**







See appendix table 4-26. Science & Engineering Indicators – 1998



The Major Federal R&D Agencies

In addition to DOD and HHS, five other agencies have R&D budgets that exceed \$1 billion. In descending order, they are: the National Aeronautics & Space Administration (NASA), with \$9.2 billion in FY 1997 obligations; DOE, \$5.9 billion; NSF, \$2.3 billion; the Department of Agriculture (USDA), \$1.4 billion; and the Department of Commerce (DOC), \$1.1 billion. These five agencies—plus DOD and HHS—account for 95 percent of U.S. Government R&D support. (See appendix table 4-27 and figure 4-13.)

NASA and NSF have seen slow expansion of their R&D budgets in the mid-1990s, with average annual constant-dollar increases estimated at 1.3 percent and 1.6 percent, respectively, between 1992 and 1997. (The NASA five-year change, however, includes a 7 percent real reduction estimated for 1996-97.)

In contrast, both DOE and USDA experienced cutbacks. DOE R&D obligations fell about 3.3 percent per year in real terms between 1992 and 1997, and USDA's dropped about 1.8 percent during the same period.

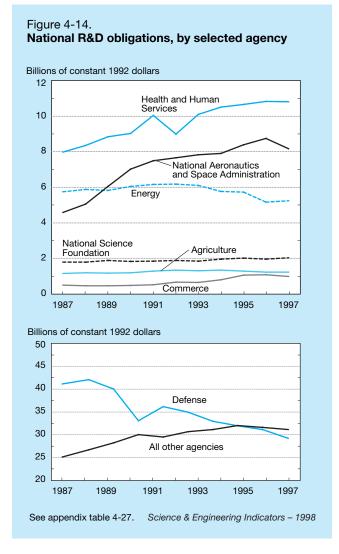
DOC joined the ranks of major R&D funding agencies a few years ago because of its Advanced Technology Program (ATP). DOC's R&D obligations topped \$600 million in FY 1992, \$800 million in FY 1994, and \$1 billion in FY 1995, where they have remained. All of the 1990s gains are largely attributable to ATP. Although ATP continues to represent a

major piece of DOC's R&D activities, its future remains uncertain. (See discussion of ATP under "Federal Partnerships With Industry.") DOC's annual level of R&D obligations is expected to have dropped 9 percent in real terms between 1996 and 1997.

Mid-Size R&D Funding Agencies

Three other agencies—the Department of Transportation (DOT), the Environmental Protection Agency (EPA), and the Department of the Interior (DOI)—each have annual R&D obligations of \$500 million to \$1 billion. Of these mid-size R&D funding agencies, DOT is expected to have shown the largest increase in R&D obligations between FYs 1992 and 1997 (7 percent per year in real terms), while a modest gain and a decrease are expected for EPA and DOI, respectively. The increase in DOT's R&D obligations reflects that agency's current emphasis on R&D related to advancements in the areas of fuel efficiency and emissions, including the Partnership for a New Generation of Vehicles, or Clean Car Agreement. (See "Technology Transfer Activities.")

²⁰Federal R&D financing has traditionally received strong bipartisan support, but a few fissures in that unanimity—differences in emphasis and priorities—surfaced in the mid-1990s. For example, the major political parties are not in agreement on the role of government in supporting programs like ATP that provide grants to profit-making companies for technology development. Budget debate over ATP has become an annual occurrence.



Federal R&D Support by Character of Work

Federal obligations for basic research, applied research, and development were an estimated \$14.7 billion, \$14.4 billion, and \$38.9 billion, respectively, in FY 1997. Overall, only modest real growth has taken place in both basic and applied research support during the mid-1990s. Each category registered average annual constant-dollar gains of 1 percent between 1992 and 1997. In contrast, the trend in federal support of development—by far the largest slice of the R&D pie—looks quite different, with development obligations in FY 1997 estimated to be more than \$2 billion below the FY 1992 level. (See appendix table 4-27.)

Basic Research. After 10 consecutive years (1981-91) of annual real increases in support for basic research, the pace of federal spending on this research type slowed in the 1990s. Although total funding of basic research is continuing to grow in this decade, there have been at least two years in which annual obligations failed to keep pace with inflation.

Five agencies obligate more than \$1 billion annually for basic research. HHS, with an estimated \$6.6 billion in FY 1997 obligations, accounts for approximately 45 percent of the total. This is more than three times the level obligated by

NSF, the second largest supporter of basic research, with \$2.1 billion in estimated obligations for FY 1997. The other three agencies are DOE (\$2.0 billion), NASA (\$1.9 billion), and DOD (\$1.1 billion). (See "DOD's Basic Research Programs.") Together, these five agencies accounted for an estimated 93 percent of all federal basic research obligations in FY 1997.

During the 1992-97 interval, HHS, with \$1.5 billion, enjoyed the largest absolute increase in basic research funding, more than four times that of NSF, which had the second highest absolute increase (\$348 million).

Of the five leading sources of basic research dollars, only DOD's obligations failed to keep pace with inflation between 1987 and 1997. The other four agencies registered average annual growth rates ranging from 1.1 percent for NSF to 3.4 percent for DOE during the same period. For DOE and NASA, the growth took place in the first part of the 10-year period:

DOD's Basic Research Programs

DOD's basic research effort has three main elements, listed below. The DOD organizations responsible for these three elements and their funding levels and projections are given in appendix table 4-28.

- ◆ Defense research sciences programs of the armed services, Defense Advanced Research Projects Agency, and the Office of the Secretary are the largest components of DOD's basic research portfolio, accounting for approximately 70 percent of the agency's total basic research funding. They also represent the largest source of DOD research funding for universities—most of which is conducted by single-investigator researchers—and support research undertaken by industry, government laboratories, nonprofit organizations, state and local governments, and FFRDCs.
- ◆ In-house Laboratory Independent Research is a program that finances basic research in support of laboratory missions and provides a research environment conducive to the recruitment and retention of outstanding scientists and engineers.
- The University Research Initiative is a collection of academic multidisciplinary research programs.

In 1995, DOD began funding six strategic, multidisciplinary research objectives. They are identified in DOD's Basic Research Plan as biomimetics (with \$10.0 million in FY 1997 funding), nanoscience (\$23.9 million), smart structures (\$8.7 million), broad band communications (\$17.2 million), intelligent systems (\$18.5 million), and compact power sources (\$9.5 million). Funding levels for each of these initiatives remained fairly constant (in current dollars) between FYs 1995 and 1997. sizable increases between 1987 and 1992 were counterbalanced by little or no growth between 1992 and 1997.

Applied Research. The annual levels in constant 1992 dollars of total federal applied research obligations in the late 1980s and early to mid-1990s produce a wavy trend. (See appendix table 4-27.) Increases in some years were matched by cutbacks in subsequent years. Overall, the annual changes average out to a real increase of 1.7 percent per year between 1987 and 1997, similar to that for basic research. The applied research numbers illustrate that cutbacks in defense-related R&D activities are being counterbalanced by increased government investment in civilian R&D programs, e.g., health and space.

Federal funds for applied research are somewhat less concentrated than basic research dollars. Four agencies (NSF drops out of the group) obligate more than \$1 billion annually for applied research and account for approximately three-fourths of all applied research obligations.

HHS is the leading supporter of applied research, with an estimated \$4.2 billion in obligations in FY 1997. A large portion of these monies supports research related to the treatment of various diseases, including cancer and AIDS. DOD is second with \$2.7 billion; followed by NASA, \$2.4 billion; and DOE, \$1.5 billion. Among these four agencies, NASA had the largest percentage increase—40 percent in inflation-adjusted dollars—in applied research obligations between 1992 and 1997. HHS registered the second highest percentage increase, with 29 percent, and the largest absolute increase at \$1.3 billion.

Although both DOD and DOE recorded healthy increases in applied research obligations in the late 1980s and early 1990s, a turnaround occurred in the mid-1990s. In FY 1997, DOD obligations are estimated to be 30 percent lower in real terms than in FY 1993; DOE's obligations are expected to be down 20 percent between 1995 and 1997. (See appendix table 4-27.)

Development. There has been no real growth in federal obligations for development since FY 1992. (See appendix table 4-27.) Cutbacks averaged an estimated 3.5 percent per year between FYs 1992 and 1997.

DOD is the source of approximately three-fourths of all federal monies spent on development. In FY 1997, DOD obligations for development were an estimated \$29.1 billion. These funds have been falling in both current and constant dollars almost continuously, with only two exceptions since FY 1989, the year they peaked at nearly \$34 billion.

The other agencies that obligate more than \$1 billion annually for development are NASA (\$5.0 billion in FY 1997), DOE (\$2.3 billion), and HHS (\$1.4 billion). NASA development obligations more than tripled between FYs 1987 and 1996; the growth rate averaged 11.4 percent per year in real terms during the nine-year period. However, a 9 percent constant-dollar decrease is estimated for FY 1997. There has been no real growth in DOE obligations since 1990; the average annual rate of decline in constant dollars was 6.5 percent through FY 1997. In real terms, little change has occurred in the annual level of HHS development obligations since 1994, although this agency experienced a major expansion in development funding during the late 1980s and early 1990s.

R&D Agency-Performer Patterns

Most federal R&D funds are actually spent in other sectors of the economy. R&D funding relationships between supporting agencies and performing sectors are well-established and tend to be fairly stable over time. (See appendix tables 4-29 and 4-30 and text table 4-6.) Examples of these funding relationships follow:

- ◆ DOD is the source of nearly three-fourths of federal R&D monies spent by industry. Nearly 95 percent of these funds support development work. Two other agencies—NASA and DOE—provide most of the other federal R&D dollars industry receives. (Interestingly, while DOD's proportion of all federal R&D obligations slated for industry fell 3 percentage points in the mid-1990s, NASA's increased by the same amount.)
- ♦ HHS is the largest supporter of federally financed R&D performed at universities and colleges, accounting for more than half of all federal R&D funds received by these institutions. In fact, most HHS R&D obligations support work performed in academia; just under one-fifth is spent internally, mostly in NIH laboratories. HHS is also the largest supplier of federal R&D funding for nonprofit organizations. Approximately 5 percent of HHS obligations are slated for industrial firms.
- ♦ NSF and DOD are the other leading supporters of R&D conducted in academic facilities. Approximately 80 percent of the NSF research budget supports projects at universities and colleges. The bulk of the remainder is split between other nonprofit organizations (7 percent), university-administered FFRDCs (6 percent), and industry (5 percent).
- ◆ DOE and DOD supply the majority of federal R&D obligations for FFRDCs. More than half the DOE R&D budget is spent at FFRDCs.
- ♦ Unlike all other federal agencies, USDA, DOC, and DOI spend most of their R&D obligations internally. Most of the R&D supported by these agencies is mission-oriented and is conducted in laboratories run by the Agricultural Research Service, the National Institute for Standards and Technology (NIST), and the U.S. Geological Survey. (See "Other NIST Programs" and appendix table 4-31.)

About half of all federal basic research dollars are spent at universities and colleges. This sector receives most of its basic research support from HHS (53 percent in FY 1997) and NSF (23 percent). Federal obligations for basic research conducted by private firms are concentrated in the research budgets of NASA (48 percent), HHS (21 percent), and DOD (12 percent). Federal in-house work on basic research programs is distributed among several agencies, with the largest portions conducted by HHS (43 percent), NASA (18 percent), and USDA (15 percent). (See appendix table 4-29.)

Text table 4-6. Estimated federal R&D obligations, by agency and performing sector: 1997

	Performer, total obligations	Primary fund	ing source	Secondary fu	nding source		
Character of work and performer	(\$ millions)	Agency	Agency Percent		Agency Percent		
Total R&D	. 68,064	DOD	48	HHS	18		
Federal intramural laboratories	. 16,404	DOD	48	HHS	14		
Industrial firms	. 30,713	DOD	74	NASA	16		
Industry-administered FFRDCs	. 1,340	DOE	70	HHS	17		
Universities and colleges	. 12,362	HHS	57	NSF	15		
University administered FFRDCs	. 3,231	DOE	63	NASA	25		
Other nonprofit organizations	. 2,884	HHS	60	DOD	12		
Nonprofit-administered FFRDCs	. 644	DOD	56	DOE	36		
Total, basic research		HHS	45	NSF	14		
Federal intramural laboratories	. 2,668	HHS	43	NASA	18		
Industrial firms	. 1,279	NASA	48	HHS	21		
Industry-administered FFRDCs	. 368	DOE	65	HHS	34		
Universities and colleges	. 7,405	HHS	53	NSF	23		
University administered FFRDCs	. 1,520	DOE	72	NASA	17		
Other nonprofit organizations		HHS	77	NSF	12		
Nonprofit-administered FFRDCs	. 83	DOE	84	HHS	13		
Total, applied research	. 14,441	HHS	29	DOD	19		
Federal intramural laboratories		DOD	21	HHS	21		
Industrial firms	. 3,521	NASA	42	DOD	34		
Industry-administered FFRDCs		DOE	83	HHS	12		
Universities and colleges	. 3.418	HHS	64	DOD	9		
University administered FFRDCs	. 611	DOE	72	NASA	15		
Other nonprofit organizations	. 930	HHS	62	AID	12		
Nonprofit-administered FFRDCs	. 109	DOE	63	DOD	13		
Total, development	. 38,890	DOD	75	NASA	13		
Federal intramural laboratories		DOD	75	NASA	14		
Industrial firms	. 25,913	DOD	82	NASA	11		
Industry-administered FFRDCs	. 334	DOE	49	DOD	44		
Universities and colleges	. 1,539	HHS	62	DOD	21		
University administered FFRDCs		DOE	46	NASA	42		
Other nonprofit organizations		DOD	40	HHS	27		
Nonprofit-administered FFRDCs		DOD	77	DOE	21		

AID = Agency for International Development; DOD = Department of Defense; DOE = Department of Energy; FFRDCs = federally funded research and development centers; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation

See appendix table 4-29.

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Federally Funded R&D Laboratories

Federal R&D obligations for all government laboratories are expected to equal \$21.6 billion in FY 1997, 32 percent of total federal R&D obligations. (See text table 4-7.)

In 1995, the U.S. General Accounting Office (GAO) conducted a census of all federal laboratories that perform R&D and are operated by federal agencies or their contractors (U.S. GAO 1996a).²¹ A total of 515 laboratories were counted.²² (See appendix table 4-32.) In addition, 65 of these laboratories had a total of 221 satellite facilities, bringing the actual federal laboratory count to 736. For purposes of this discussion, GAO's identification of 515 laboratories will be used.

Seventeen federal departments and independent agencies have laboratories; five (the Department of Housing and Urban Development, Department of Labor, Agency for International Development, Social Security Administration, and U.S. International Trade Commission) have none. At the time of the study, each state had a least one federal laboratory; California had the most with 46. Five laboratories (three run by USDA and two by the Navy) are located in foreign countries.

Of the 515 laboratories, 361 had operating budgets under \$10 million in FY 1995, 101 were in the \$10 to \$100 million range, and 53 had operating budgets exceeding \$100 million.

With 185, USDA had the largest number of laboratories in 1995. However, its operations are relatively small in size—with a median operating budget of \$2.1 million in FY 1995. According to the GAO survey, DOD, DOE, HHS, and NASA laboratories accounted for 88 percent of all federal R&D laboratory funding in FY 1995. Although most federal laborato-

²¹Excluded from GAO's survey were facilities whose purpose is to test or analyze samples for chemical, physical, or biological properties, as these activities are not considered R&D.

²²The various NIH institutes located at the main NIH campus in Bethesda, Maryland, were counted as a single laboratory.

Other NIST Programs

In addition to ATP, the NIST portfolio includes laboratory research and services, the Manufacturing Extension Partnership (MEP), and the Baldrige National Quality Program. These programs were funded at \$265 million, \$95 million, and \$3 million, respectively, in FY 1997.

Laboratory Research and Services. Seven NIST laboratories and the Technology Services organization provide technical leadership for measurement and standards. The laboratories are Electronics and Electrical Engineering, Manufacturing Engineering, Chemical Science and Technology, Physics, Materials Science and Engineering, Building and Fire Research, and Information Technology. To provide NIST with the research environment required for 21st century science, a new Advanced Chemical Sciences Laboratory is under construction, and an Advanced Measurement Laboratory is planned.

Manufacturing Extension Partnership. MEP is a nationwide system of manufacturing extension centers. These centers provide all small and medium-size manufacturers in the United States access to industrial extension services. They also act as gateways into a network of technical resources, services, and expertise related to modern best business practices and manufacturing meth-

odologies. Congress directed NIST to begin helping smaller manufacturers compete in domestic and international markets through passage of the Omnibus Trade and Competitiveness Act of 1988, which also established ATP. In contrast to the solely mission-related R&D agendas of other S&T-related programs, both MEP and ATP were designed exclusively to boost U.S. competitiveness. Since 1989, MEP has made awards for extension center operations covering all 50 states and Puerto Rico.

Baldrige National Quality Program. The Malcolm Baldrige National Quality Improvement Act of 1987 established an annual National Quality Award to promote awareness of quality excellence, to recognize quality achievements of U.S. companies, and to publicize successful quality strategies. The Secretary of Commerce and NIST were given responsibility to develop and administer the award with cooperation and financial support from the private sector. Awards may be given each year in each of three categories: manufacturing companies or subunits, service companies or subunits, and small businesses. There were 32 award winners between 1988 and 1997.

Text table 4-7. Estimated federal R&D obligations, by selected agency and government laboratory: FY 1997 (Millions of dollars)

Agency	Total R&D	Total lab	Intramural	FFRDCs
Total, all agencies	68,064	21,618	16,404	5,214
Department of Agriculture	1,369	922	922	*
Agricultural Research Service	697	663	663	*
Forest Service	180	154	154	*
Department of Commerce	1,096	712	712	*
National Institute for Standards & Technology	542	226	226	*
National Oceanic & Atmospheric Administration	541	475	475	*
Department of Defense	32,964	8,710	7,919	791
Department of Energy	5,895	3,708	507	3,201
Department of Health & Human Services	12,185	2,632	2,362	270
National Institutes of Health	11,471	2,126	1,857	269
Department of the Interior	574	508	508	*
Geological Survey	524	483	483	*
National Aeronautics & Space Administration	9,204	3,109	2,301	808

^{* =} less than \$500,000; FFRDCs = federally funded research and development centers

NOTE: These figures reflect funding levels as reported by federal agencies in March through October 1996.

See appendix tables 4-27, 4-31, and 4-33.

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ries are operated by federal agencies and employ federal personnel, 62 of the 515 were administered by businesses, universities, or other nonprofit organizations through a contract or cooperative agreement with a federal agency.

Federally Funded Research and Development Centers. Thirty-eight of the 736 federal R&D facilities identified by

GAO are FFRDCs.²³ They include research laboratories, R&D laboratories, study and analysis centers, and systems engineering/systems integration centers.

²³FFRDCs include government-owned and contractor-operated laboratories, and laboratories owned by nongovernment organizations that do virtually all their work for the government.

R&D obligations for these 38 facilities are expected to total \$5.2 billion in FY 1997, about 22 percent below the 1992 level. (See appendix table 4-33.) The decline is a reflection of the overall downward trend in defense-related R&D associated with the end of the Cold War. For example, the United States no longer manufactures nuclear warheads, the former mainstay of some of the laboratories. The 1992-97 reduction also reflects removal of FFRDC designation from three facilities administered by industrial firms (formerly there were nine industry-administered FFRDCs; now there are six). Additionally, university- and nonprofit-administered FFRDCs experienced funding cutbacks of 16 percent and 14 percent, respectively, between 1992 and 1997.

Of the FY 1997 FFRDC total of \$5.2 billion, \$3.2 billion is obligated for 18 university-administered laboratories, \$1.3 billion for the 6 run by industrial firms, and \$644 million for the 14 facilities operated by nonprofit organizations.

The most well-known FFRDCs are often referred to as "national laboratories." These 10 facilities are funded by DOE. Three were established during World War II specifically to design and build nuclear weapons; six others were created in the decades immediately following the war to develop commercial applications of nuclear technology.²⁴

Three of the 10 national laboratories have R&D expenditures that exceed \$0.5 billion. They include Sandia, with FY 1995 obligations of about \$650 million; Los Alamos, \$540 million; and Lawrence Livermore, \$500 million. The latter two are administered by the University of California; Sandia is administered by a subsidiary of Lockheed Martin. All three facilities recorded major cutbacks in their R&D programs in the mid-1990s. (See appendix table 4-35.)

Despite an increase in collaborative endeavors with the outside world (see "Technology Transfer Activities"), most of the work conducted at FFRDCs is still defense-related R&D funded by DOE. This agency provided an estimated \$3.2 billion in FY 1997, which was a little more than 60 percent of all federal R&D dollars spent at FFRDCs. (See appendix table 4-33.) Between FYs 1992 and 1997, DOE funding fell about 20 percent. DOE is the sponsoring agency for 17 FFRDCs, 11 of which are administered by universities, 4 by industrial firms, and 2 by nonprofit organizations.

NASA now ranks second in terms of R&D funds spent at FFRDCs (it captured second place from DOD in 1995); its FY 1997 R&D obligations are expected to total \$800 million. This amount is down about 23 percent from the FY 1995 level of just over \$1 billion, but about the same as the levels reported in 1992 and 1994. Most of these funds are spent at the agency's only FFRDC, the Jet Propulsion Laboratory administered by the California Institute of Technology. This laboratory, which serves as NASA's principal center for solar

system exploration, is now the largest single FFRDC in terms of R&D financial resources.

FFRDC R&D obligations by DOD are expected to be about \$720 million in FY 1997. Total DOD support to FFRDCs has been falling every year since 1992, and now stands at less than half of the 1992 level. As mentioned, one of the reasons for the decline is the removal of FFRDC designation from three industry-administered centers; however, funding also fell about 70 percent (\$465 million) at university-administered FFRDCs and 32 percent (\$171 million) at nonprofit organizations between 1992 and 1997. DOD is the sponsor of 11 FFRDCs: 2 administered by universities and 9 by non-profit organizations.

The other agencies that sponsor FFRDCs are NSF, HHS, the Nuclear Regulatory Commission, DOT, and the Treasury Department. Among this group, only NSF sponsors more than one FFRDC; four of its five centers are administered by universities, the fifth by a nonprofit organization. HHS is the fourth largest agency in terms of FFRDC support, with most of its FY 1995 obligations supporting research performed at the National Cancer Institute's Frederick Cancer Research and Development Center, which is administered by four different companies.

Inter-Sector and Intra-Sector Partnerships and Alliances

Collaboration Among Firms and Across Sectors

Cooperative R&D is now an important tool in the development and leveraging of S&T resources. For at least a decade, a combination of several factors has greatly changed the research environment, prompting the creation of interand intra-sector—and international—partnerships and other collaborative alliances and enabling them to flourish. Economic, legal, and cultural reasons are responsible for the growth in cooperative R&D:

- ◆ Economic. Collaboration allows individual partners to leverage their resources, thus reducing costs and risks and enabling research ventures that might not have been undertaken otherwise. In addition, the rise of international competition has forever changed the playing field on which U.S. companies operate, calling for new approaches to innovation.
- ◆ Legal. New laws have been enacted to encourage collaboration among companies and across sectors. (See text table 4-8.)
- ♦ Cultural. The traditional reluctance to work with researchers in other organizations—both public and private—has gradually been receding. Attitudes like "not invented here" and an anti-industry bias are far less prevalent than they used to be. Another example of this cultural change is that DOD is now looking first to the commercial sector as a source of new technology for its military needs.

²⁴The 10 laboratories are Lawrence Berkeley, Los Alamos, and Oak Ridge, which were established during World War II to design and build nuclear weapons; Argonne, Brookhaven, Sandia, Idaho Engineering, Lawrence Livermore, and Pacific Northwest, which were created between 1946 and 1965 to advance civilian uses of nuclear technology; and the National Renewable Energy Laboratory, which was established to conduct R&D on alternative energy sources and was given FFRDC status in 1991(U.S. GAO 1994).

Text table 4-8.

Principal federal legislation related to cooperative technology programs

Stevenson-Wydler Technology Innovation Act (1980). Required federal laboratories to facilitate the transfer of federally owned and originated technology to state and local governments and to the private sector. The Act includes a requirement that each federal laboratory spend a specified percentage of its R&D budget on transfer activities and that an Office of Research and Technology Application be established to facilitate such transfer.

Bayh-Dole University and Small Business Patent Act (1980). Permitted government grantees and contractors to retain title to federally funded inventions and encouraged universities to license inventions to industry. The Act is designed to foster interactions between academia and the business community. This law provided, in part, for title to inventions made by contractors receiving federal R&D funds to be vested in the contractor if they are small businesses, universities, or not-for-profit institutions.

Small Business Innovation Development Act (1982). Established the Small Business Innovation Research (SBIR) Program within the major federal R&D agencies to increase government funding of research with commercialization potential in the small high-technology company sector. Each federal agency with an R&D budget of \$100 million or more is required to set aside a certain percentage of that amount to finance the SBIR effort.

National Cooperative Research Act (1984). Encouraged U.S. firms to collaborate on generic, precompetitive research by establishing a rule of reason for evaluating the antitrust implications of research joint ventures. The Act was amended in 1993 by the National Cooperative Research and Production Act, which let companies collaborate on production as well as research activities.

Federal Technology Transfer Act (1986). Amended the Stevenson-Wydler Technology Innovation Act to authorize cooperative research and development agreements (CRADAs) between federal laboratories and other entities, including state agencies.

Omnibus Trade and Competitiveness Act (1988). Established the Competitiveness Policy Council to develop recommendations for national strategies and specific policies to enhance industrial competitiveness. The Act created several new programs, including the Advanced Technology Program and the Manufacturing Technology Centers in the Department of Commerce's National Institute of Standards and Technology to help U.S. companies become more competitive.

National Competitiveness Technology Transfer Act (1989). Part of the Department of Defense authorization bill, this act amended the Stevenson-Wydler Act to allow government-owned, contractor-operated laboratories to enter into cooperative R&D agreements.

Defense Conversion, Reinvestment, and Transition Assistance Act (1992). Initiated the Technology Reinvestment Project to establish cooperative, interagency efforts that address the technology development, deployment, and education and training needs within both the commercial and defense communities.

SOURCE: C. Coburn, ed., Partnerships: A Compendium of State and Federal Cooperative Technology Programs (Columbus, OH: Battelle Press, 1995).

Although data on financial resources invested in multifirm and multi-sector collaborative R&D activities are sparse, evidence reveals a major upswing in the number of S&T partnerships since the early 1980s.²⁵ (See "State R&D Issues: High Geographic Concentration and New Data on State Government R&D Support.") Several indicators of cooperative R&D activity are discussed in this section, which covers only domestic alliances. See "International Strategic Technology Alliances," later in this chapter, for information on international collaborative R&D activities.

Industrial R&D Consortia

In the early 1980s, increasing international competition and the resulting erosion in U.S. technological leadership led legislators and policymakers to conclude that existing U.S. antitrust laws and penalties were too restrictive and could be impeding the ability of U.S. companies to compete in the glo-

bal marketplace. U.S. companies were at a disadvantage compared to their foreign counterparts, because of an outdated antitrust environment—designed to preserve domestic competition—that prohibited them from collaborating on most activities, including R&D.

Therefore, in 1984, restrictions on multi-firm cooperative research relationships were lifted with the passage of the National Cooperative Research Act (NCRA). (See text table 4-8.) The law was enacted to encourage U.S. firms to collaborate on generic, precompetitive research. To gain protection from antitrust litigation, NCRA requires firms engaging in research joint ventures to register them with the U.S. Department of Justice.²⁶ In 1993, Congress again relaxed restrictions—this time on cooperative production activities—by

²⁵For example, the Industrial Research Institute's annual survey of its membership shows more than one-third of the respondents (over half in 1996) anticipating an increase in alliances and joint ventures between 1993 and 1998 (IRI 1997).

²⁶According to NCRA, an RJV is "any group of activities, including attempting to make, making, or performing a contract, by two or more persons for the purpose of (a) theoretical analysis, experimentation, or systematic study of phenomena or observable facts, (b) the development or testing of basic engineering techniques, (c) the extension of investigative findings or theory of a scientific or technical nature into practical application for experimental and demonstration purposes... (d) the collection, exchange, and analysis of research information, or (e) any combination of the [above]." RJV members can be from different sectors as well as from different countries.

State R&D Issues: High Geographic Concentration and New Data on State Government R&D Support

R&D is substantially concentrated in a small number of states, a solidly entrenched configuration created by past public and private sector choices influenced by multiple economic and scientific considerations.

One-half of the \$177 billion spent on R&D in the United States in 1995 was expended in six states—California, Michigan, New York, Massachusetts, New Jersey, and Texas. Add five more states—Illinois, Pennsylvania, Maryland, Ohio, and Washington—and the proportion jumps to two-thirds of the national total. (These figures do not include \$6 billion of the national R&D total that could not be allocated to individual states.) One-fifth of all U.S. R&D funds, or \$36 billion, was spent in California alone. In each of the next 11 leading states, R&D spending exceeded \$5 billion. (See appendix table 4-55.) In contrast, the smallest 20 states together accounted for about \$8 billion, or less than 5 percent of the R&D conducted nationwide in 1995.

Not coincidentally, states that are national leaders in total R&D performance also usually rank among the leading sites in industrial and academic R&D performance. (See appendix table 4-55.) Of the 11 states that lead in total R&D:

- ♦ All but Maryland ranked among the top 11 in industrial R&D performance; Florida (12th for total R&D) held the 10th slot.
- All but New Jersey and Washington ranked among the top 11 in academic R&D performance; North Carolina and Georgia (16th and 23rd for total R&D, respectively) made the short list instead.

There is somewhat more variation in the distribution of federal R&D performance. Although California ranks third, the top spots were held by Maryland and the District of Columbia, followed by Virginia. These positions reflect the concentration of federal research facilities, such as NIH, in the Washington, D.C., metropolitan area.

State governments have played an increasingly important role in fostering research collaborations and in helping leverage R&D funds of in-state universities and industry. They also spend an estimated \$2.5 billion on R&D activities themselves (Battelle forthcoming). According to preliminary data on state government R&D spending in 1995, California, Florida, and Pennsylvania accounted for the largest funding totals. These were the only three states to individually spend more than \$200 million on R&D; combined, the three spent almost \$700 million. (See appendix table 4-54.) Most of these monies went to support research undertaken on our nation's campuses. Nationwide, about \$400 million was spent in state government agency laboratories. As a percentage of total state funding for all services, however, states overall spent a somewhat meager 0.35 percent on R&D. In only three states—Nebraska, Kansas, and Georgia—did the R&D share exceed 1 percent of state government spending totals, according to available preliminary data.

passing the National Cooperative Research and Production Act, which enables participants to work together to apply technologies developed by their RJVs.

NCRA seems to be accomplishing its objectives. By the end of 1996, more than 665 RJVs had been registered; organizations such as Sematech have helped U.S. industries regain leadership in global markets for high-tech products like semiconductors. Although the annual number of RJV filings has increased in most years since the passage of NCRA, the largest increases were in the two most recent years, including an unprecedented 115 in 1995 and an additional 97 in 1996. (See figure 4-15.) This recent increase may reflect activity from ATP participation. (See "Advanced Technology Program.") Although data are not available on the level of resources invested in these projects, results of two investigations (Link 1996b and Vonortas 1997) revealed the following:

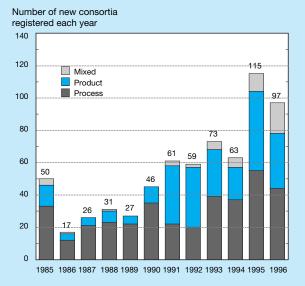
♦ The average number of members in each of the 665 RJVs is approximately 13. The average number of members in an RJV increased to a maximum of approximately 35 in

1988 and then declined in subsequent years. In 1995, the average membership was about seven, the smallest since NCRA's passage.

- ♦ The vast majority—86 percent—of RJV members are profit-making firms. Nonprofit groups, including universities and colleges, hold 10 percent of the memberships; and government agencies and organizations, 4 percent. Registered RJVs with federal participation include some of the more well-known consortia, e.g., Sematech (DOD) and the Advanced Battery Consortium (DOE).
- ♦ Most of the research conducted by RJVs has been process-oriented, although during 1991 and 1992, the number of new filings for product-oriented RJVs exceeded the number of those claiming process-oriented research. In general, the more recent data (1991-96), show less skewing toward process-oriented research than do data for 1985-90. In pre-1991 years, the RJV research focus was predominantly process-oriented.

Figure 4-15.

Growth in R&D consortia registered under the National Cooperative Research and Production Act



SOURCE: A.N. Link, "Research Joint Ventures: Patterns From Federal Register Filings," Review of Industrial Organization, Vol. 11, No. 5 (October): 617-28.

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- ◆ Telecommunications is the dominant RJV technical area, accounting for about one-fifth of the total. The next largest areas are environmental²⁷ and transportation, each accounting for about 10 percent of the total; followed by advanced materials and energy, each at 9 percent; and software, at 7 percent.
- Few RJVs involve any type of defense-related research or research in fields where intellectual property rights tend to be well-enforced, e.g., biotechnology, medical equipment, and pharmaceuticals.
- ♦ About 30 percent of RJV members are foreign-based. The most well-represented countries (after the United States) are, in order, the United Kingdom (with 4.9 percent of the total number of entities), Japan (4.6 percent), Canada (3.6 percent), Germany (3.2 percent), and France (2.2 percent).

Federal Programs

Much has been written about the Federal Government's changing role in the development and deployment of new technologies. The postwar "spinoff" model, in which certain industries (e.g., aerospace, computer, and biotechnology) built much of their competitive strength off the government's investment in R&D, has given way to a new model—one in which evidence is pointing to greater government benefits derived from the commercial sector's work in technology development than the other way around. For example, technologies in the software, computer, semiconductor, telecommunication, advanced materials, and manufacturing areas that are pushing the state of the art in U.S. military hardware and equipment were mostly developed in the private sector.

The public sector's evolving role in S&T—and the upsurge in international competition faced by U.S. firms—has led to another change in which the government is taking on the role of "partner" rather than merely customer in federally supported S&T programs. Since 1980, several new programs have come into being, all with the major goal of having the government partner with the private sector to strengthen the U.S. position in international markets for high-tech goods and services. This new approach to technology development and deployment includes the following guideposts:

- Economic (i.e., commercial potential) as well as technical considerations should play a role in selecting projects to receive public sector support.
- ♦ Cost-sharing is crucial, because it ensures that private sector partners have a stake in the R&D's outcome and success.
- ♦ The private sector should have a major role in project selection and management, because economic growth and jobs—the main benefits of R&D commercialization—are the role of the private sector (U.S. DOC/OTP 1996).

It should be noted that although these new public-private partnerships account for only a small portion of total federal R&D investment in technology, they seem to have broad, widespread support within the private sector.²⁸

Technology Transfer Activities

Technology transfer activities became an important mission component of federal laboratories in the late 1980s. Of course, some agencies, including USDA's agricultural research

²⁷Environmental research is probably the best example of an area in which market failure results in underinvestment in research. And, because entire industries are affected and can benefit from collaboration, it is a highly appropriate area for joint research. For example, several U.S. companies and national laboratories are involved in a collaborative effort to discover environmental processing techniques for aerospace materials. Although environmental and safety regulations raise the cost of R&D for many companies—especially those in the chemicals, petroleum, and transportation equipment industries—they also promote research that provides numerous societal benefits (Council on Competitiveness 1996).

²⁸Support for these programs has been documented by the National Association of Manufacturers, Industrial Research Institute, and Semiconductor Equipment and Materials International (Council on Competitiveness 1996). In addition, a GAO study of manufacturing extension programs found high levels of private sector satisfaction with these programs (U.S. GAO 1995). Another survey revealed a high level of satisfaction among industry officials who had used federal laboratories: e.g., 89 percent of respondents considered their interactions to be a good use of their companies' resources. Even in cases where the costs exceeded the benefits, many industry officials still expressed high levels of satisfaction (Bozeman, Papadakis, and Coker 1995).

experiment stations and NASA's civilian aeronautics programs, have always shared their research with the private sector.²⁹ But after Congress passed several laws, including the Stevenson-Wydler Technology Innovation Act (1980), the Federal Technology Transfer Act (1986), and the National Competitiveness Technology Transfer Act (1989), other agencies were given the go-ahead to open their laboratory doors. (See text table 4-8.) In addition, because of budget cutbacks and a decline in defense-related work, federal laboratories have an even greater incentive to stretch their resources through partnering with industry, academia, and state organizations to work on commercially inspired initiatives.³⁰

Growing Public-Private Cooperation

Evidence of growing cooperation between federal laboratories and private sector entities can be seen in the number of cooperative research and development agreements (CRADAs) executed in the past few years.³¹ These formal agreements were created by Congress under "the belief that federal laboratories hold valuable technological assets and that those assets should be used not only for pursuing an agency's mission but also to improve the competitive position of U.S. firms" (U.S. DOC/OTP 1996). Thus, the purpose of CRADAs is to facilitate and expedite the transfer of technology from federal laboratories to the private sector by enabling private sector researchers to gain access to and take advantage of government R&D expertise and resources.

Between 1992 and 1995 (the most recent year for which data are available), 3,512 CRADAs were executed. The annual number of new CRADAs more than doubled between 1992 and 1994, going from just over 500 to more than 1,100. However, the annual number of new agreements fell the next year to just over 1,000. (See text table 4-9.)

Text table 4-9.

Number of new cooperative R&D agreements executed, by agency

Agency	Total	1992	1993	1994	1995
Total	3.512	502	877	1,130	1,003
Agriculture	270	41	103	72	54
Commerce	412	86	147	97	82
Defense	1,001	131	201	298	371
Energy	1,553	160	367	564	462
Environmental					
Protection	43	20	5	10	8
Health & Human					
Services	136	53	25	36	22
Interior	61	3	15	39	4
Transportation	36	8	14	14	0

SOURCE: Technology Publishing Group, *The 1996 CRADA Handbook: Federal Government Cooperative Research and Development Agreements Executed in 1995* (Washington, DC: 1997).

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During the 1992-95 period, DOE executed the largest number of new CRADAs (1,553), followed by DOD (1,001), DOC (412), and USDA (270). Interestingly, every agency except DOD reported a lower number of new CRADAs executed in 1995 than in the previous year. (See text table 4-9.) Government agencies seem to be backing away from these agreements, in contrast to the early 1990s when there was a strong push for them (Larson 1997). DOE had the largest absolute reduction in new CRADAs, as recent budget cutbacks left decreased support for new agreements and prompted termination and scaling back of existing ones, especially at DOE weapons laboratories (Technical Insights 1996).

About 75 percent—or 749—of the 1,003 1995 CRADAs were executed by individual industrial firms; consortia and nongovernment organizations were responsible for 87; universities, 86; and state and local governments, 10.

The total number of private sector partners in the 1995 agreements was 688; 124 organizations executed two or more CRADAs during 1995.

The U.S. Council on Automotive Research, which represents industry's role in the Clean Car Agreement between the Clinton Administration and the "big three" auto makers (and is responsible for R&D associated with the Partnership for a New Generation of Vehicles), 32 executed 32 new CRADAs in 1995, far more than any other private sector partner. (See figure 4-16.) General Motors was a distant second with 15, followed by Dupont with 8, and the University of Maryland with 6. Four companies—AT&T, Chevron, Martin Marietta (now Lockheed Martin), and SI Diamond Technologies—each executed five agreements; and seven organizations executed four.

²⁹For example, NASA has played a lead role in the development of new technologies in propulsion and aerodynamics that have made crucial contributions to the success of the commercial aircraft industry.

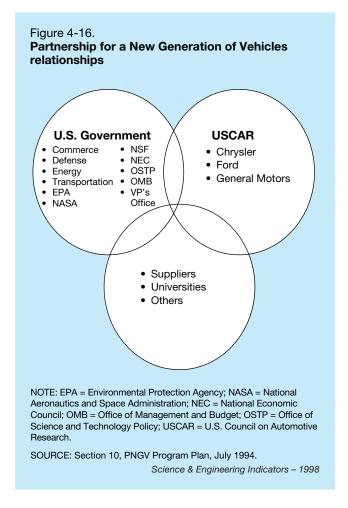
³⁰According to one survey, companies' major incentives for working with federal laboratories are leveraging R&D, gaining access to federal expertise and facilities, and developing business opportunities—in that order. Respondents also noted that informal types of interaction were the most frequent and effective. "There is a danger that too much emphasis will be placed on evidence of tangible economic payoffs (CRADAs [cooperative research and development agreements], licenses) as measures of success, with insufficient recognition of the value to companies of access to state-or-the-art knowledge and equipment" (U.S. DOC/OTP 1996).

As an example of the growing interaction between federal laboratories and industry, member companies have hosted senior scientists and engineers from Los Alamos, under a special Industrial Research Institute program (Larson 1997a)

On the other hand, pharmaceutical and biotechnology companies have historically been reluctant to work directly with government (NIH) laboratories because of intellectual property and pricing issues (the government reserves the right to control the price of products exclusively licensed by pharmaceutical companies), despite passage of the Technology Transfer Act of 1986, which authorized federal intramural laboratories—including NIH—to offer CRADA partners preference in licensing any intellectual property developed under the CRADA.

³¹Most of the information in this section was obtained from Technology Publishing Group (1997).

³²The Partnership's purpose is to create a zero-pollution, 80-mile-per-gallon automobile marketable early in the next century.



Federal Partnerships With Industry

Two federal technology partnership programs were started in the 1990s: DOC's Advanced Technology Program and DOD's Technology Reinvestment Project (TRP). The purpose behind both programs was to spur the development and deployment of high-risk enabling technologies through an industry-driven, cost-sharing process, whereby industry proposed the research and supplied at least half the funding. Of the two programs, only ATP survives, and its budget was sharply reduced in 1996.

Advanced Technology Program. ATP was designed "to act as a catalyst for the development of high-risk technologies that have broad applications and the potential for large economic impact" (U.S. DOC/OTP 1996), but few federal R&D programs have sparked as much controversy as this one. Neither criticism nor praise for ATP are in short supply. Although the program came into being (as part of the Omnibus Trade and Competitiveness Act of 1988) with substantial bipartisan support, it has come under attack in recent budget debates. The Republican-led Congress has been eager to zero-out a program that provides federal research assistance to cor-

porations.³³ ATP's survival is largely attributable to strong backing from the Clinton Administration and support from the high-tech business community. Although congressional efforts to eliminate the program have yet to succeed, ATP's budget was cut by a third in 1996. Funding remained level in FY 1997 at \$218 million, almost 40 percent of NIST's \$581 million in appropriated funding.³⁴

Between 1990 and 1996, more than \$2 billion in public and private funds were invested in a total of 288 ATP projects—184 awards to single applicants and 104 to joint ventures. (See appendix table 4-36 and figure 4-17.) Only about 10 percent of ATP proposals receive funding.

The government's share of ATP is closing in on \$1 billion, while private support is slightly above the billion-dollar mark. The 184 single-applicant projects have a total funding level of \$600 million, with ATP funds making up slightly more than half that amount and companies providing the remaining portion. The average award size across single applicants and joint ventures is \$3.4 million.³⁵ The 104 joint ventures have a total funding level of \$1.4 billion—with just over half of those monies provided by private sector participants.

ATP runs two kinds of competitions—general and focused. Companies or consortia can submit proposals for support in any technology area(s) in the general competitions, while the focused competitions are for specific technologies. The funding split between the two types of competitions is about 40/60 (through 1996). Proposals are selected through a peer review process and are judged on both their technical merit and their potential for commercial success.³⁶

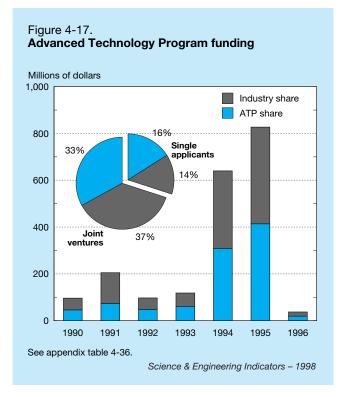
ATP has undergone extensive evaluation. NIST-funded case studies and surveys conducted a few years after the program's inception revealed ATP's success in fostering highrisk research that would not have been attempted otherwise. Other benefits were reduced time-to-market, accelerated R&D time tables, job creation, and the formation of strategic R&D alliances. The full economic impact of the program will be examined in future studies, as more projects complete the R&D phase and reach commercial development (U.S. DOC 1995).

³³Because ATP is a source of federal funding for technology development that benefits the private sector—and the grants do not have to be repaid or the research results shared—many consider ATP to be a form of "corporate welfare." In the opposite camp are those who believe government has an important role to play in fostering industrial competitiveness by funding research that would not happen without public support. According to one advocate, "ATP plugs a gap that used to make U.S. research vulnerable to foreign competition." The industry official was referring to the perspective that the Federal Government's traditional method of funding research by providing support to academic institutions enables foreign companies to take advantage of the research results at little cost to them (MSNBC 1997).

³⁴A \$7 million rescission from the \$225 million appropriated for ATP made the actual FY 1997 funding level \$218 million.

³⁵The largest award made was \$31.5 million, to a joint venture. Single applications are limited to \$2 million (MSNBC 1997).

³⁶About 45 ATP projects are classified as "completed," which means the ATP-funded R&D has been done. Several have produced finished products already in the marketplace (MSNBC 1997).



A 1995 GAO study of ATP gave the program a mixed review.³⁷ While it found the program to be meeting some of its goals—including fostering the formation of joint ventures and facilitating the funding of risky, precompetitive research—the findings also suggested that ATP is funding "research projects that would have been funded by the private sector as well as those that would not" (U.S. GAO 1996b). Not surprisingly, this conclusion provided ammunition for both opponents and proponents of the program (Long 1996).

In response to the congressional criticism, the Secretary of Commerce ordered a report on ATP in March 1997 (U.S. DOC 1997). The following recommendations from this evaluation are being implemented:

- Project evaluation criteria will be modified to put more emphasis on joint ventures and consortia and less on individual applications from large companies.
- ♦ The cost-share ratio for large companies applying as single applicants will be increased to a minimum of 60 percent.
- Linkages with the private sector venture capital community will be strengthened.
- ♦ State participation through state-sponsored business and technology support programs will be encouraged.

Defense-Related Programs. Defense policy has undergone major changes during the 1990s. Not only has the cessation of Cold War hostilities had a major impact on the size and allocation of the defense budget, but economic considerations and technological advancements are also affecting the

U.S. approach to national security. While base closings grab front-page coverage, the less sensational aspects of defense downsizing—namely the paring and reshaping of programs that support scientific research and new technology development—also are being addressed.

During the 1990s, DOD has been pursuing a "dual-use" strategy; i.e., it has been providing financial support to the private sector to develop and deploy technologies likely to have both commercial and military applications. For example, semiflat-panel displays, semiconductors, and smart-weapons technology all have applications in both the commercial and military sectors. The benefits to the government from this approach are assumed to be reduced procurement costs and faster weapons development and improvement cycles.

However, the dual-use approach has attracted a considerable amount of controversy. Opponents contend that it represents an attempt at industrial policy inappropriate for the government in a free-market system. Lack of congressional support led to the demise in 1995 of TRP—the centerpiece of dual-use efforts earlier in the decade.³⁸

TRP's successor is called the Dual-Use Applications Program (DUAP). The mission of DUAP is to develop prototypes for and demonstrate new approaches to incorporating commercial research, technology, products, and processes into military systems. The main difference between this and previous dual-use efforts is that the armed services will play a major role by selecting the technology areas they wish to emphasize and support. The FY 1997 DOD appropriation was \$135 million to begin funding two DUAP initiatives:

- 1. The Science and Technology Initiative, with an FY 1997 budget of \$85 million. The money will be used to fund projects to develop militarily useful, commercially viable technology. One-quarter of the funding for each project will come from the S&T program, one of the three service branches will supply another quarter, and the remaining half will come from the company performing the work.
- 2. The Commercial Operations Support Savings Initiative (COSSI), with an FY 1997 budget of \$50 million. The money will be used to develop prototypes that leverage commercial R&D to improve the performance of military systems and to decrease operations and support costs. Thirty projects (10 Army, 14 Navy, and 6 Air Force) out of

 $^{^{37}{\}rm GAO}$ surveyed all winning and "near-winning" applicants during ATP's first four years; the response rate was 100 percent.

³⁸TRP competitions were held in 1993, 1994, and 1995. The purpose of the program was to fund public-private partnerships to develop technologies for new products and processes meeting both military and commercial needs. It was managed by the Defense Advanced Research Projects Agency, with participation by several other federal agencies. All federal funding, however, was provided by DOD, with industry providing an equal or higher share of financial support for each project. The most recent data show DOD spending to be approximately \$700 million on a total of 131 projects awarded TRP support. Focus areas for the 1995 winners were affordable advanced controls technologies, biological sensors and multi-organ diagnostic screening, digital wireless communications and networking systems, microelectromechanical systems applications, operations other than war/law enforcement, and small precision optics manufacturing technology. (See "Independent Research and Development Provides Additional Defense Funding.")

81 proposals were selected for funding in the 1997 competition.³⁹

There is also 1997 funding for a third dual-use program. The Commercial Technology Insertion Program will provide approximately \$7.5 million in FY 1997 to adapt a commercial signal processing technology to the APG-63 Radar and to qualify microelectromechanical sensors for use in military systems.

Other Federal Cooperative Technology Programs. Other examples of government-industry-academic collaborations include those made under the NSF-funded Science and Technology Centers and Supercomputer Centers and the Grant Opportunities for Academic Liaison with Industry Program. These programs stimulate interactions among industry, academia, and government, mostly through personnel exchanges—which are often identified as the most effective way of transferring knowledge across sectors.

Cross-cutting Administration initiatives have also promoted inter-sectoral collaboration. For example, since 1991, the federal High Performance Computing and Communications (HPCC) Program has been responsible for long-term R&D in advanced computing, communications, and information technologies. The Next Generation Internet, which is part of the HPCC initiative, is bringing together users, network providers, and researchers from all sectors to develop new networks and advanced applications technologies, including new multimedia services for homes, schools, and businesses. (See chapter 8.)

International Comparisons of National R&D Trends

Absolute levels of R&D expenditures are indicators of the breadth and scope of a nation's S&T activities. 40 The relative strength of a particular country's R&D effort is further indicated through comparison with other major industrialized countries. This section provides such comparisons of international R&D spending patterns. It examines absolute and relative expenditure trends, contrasts performer and source structural patterns, reviews the foci of R&D activities, and looks at government priorities and policies. While R&D performance patterns by sector are quite similar across countries, national sources of support differ considerably. Foreign sources of R&D have been increasing in practically all countries.

U.S. leadership in terms of financial investment in R&D compared to other countries' remains largely unchanged from a decade ago, with the U.S. R&D total nearly equal to that of the next six largest performers combined. Virtually all of the major R&D-performing countries experienced a slowing in the growth of R&D funds in the early 1990s, and most continue to feel the funding pinch. The United States and Japan may be exceptions, each reporting significant increases in R&D activity for 1995.

Total Research and Development Trends

Absolute Levels

Worldwide Distribution of R&D. The worldwide distribution of R&D performance is concentrated in several industrialized nations. 41 Of the approximately \$410 billion in 1995 R&D expenditures estimated for the 28 Organisation for Economic Co-operation and Development (OECD) countries, 90 percent is expended in just seven (OECD 1997b). These estimates are based on reported R&D investments (for both defense and civilian projects) converted to U.S. dollars with purchasing power parity (PPP) exchange rates. (See appendix table 4-2.) Although PPPs technically are not equivalent to R&D exchange rates, they better reflect differences in countries' laboratory costs than do market exchange rates (MERs). (See "Purchasing Power Parities: Preferred Exchange Rates for Converting International R&D Data.")

The United States accounts for roughly 44 percent of the industrial world's R&D investment total and continues to outdistance, by more than 2 to 1, the research investments made in Japan, the second largest R&D-performing country. Not only did the United States spend more money on R&D activities in 1995 than any other country, but it also spent almost as much by itself as the rest of the major industrialized "Group of Seven" (G-7) countries combined—Japan, Germany, France, the United Kingdom, Italy, and Canada. (See appendix table 4-42.) In only four other countries—the Netherlands, Australia, Sweden, and Spain—do R&D expenditures exceed 1 percent of the OECD R&D total (OECD 1997b).

Worldwide Slowing of R&D Spending. In 1985, spending in non-U.S. G-7 countries was equivalent to 91 percent of U.S. R&D expenditures that year, climbing steadily to peak at 107 percent of the U.S. total in 1992. A worldwide slowing in R&D performance—more pronounced in other countries than in the United States—lowered 1995 R&D spending in these six countries to 101 percent of the U.S. total. (See figure 4-19.)

Total R&D expenditures stagnated or declined in each of the largest R&D-performing countries in the early 1990s. (See figure 4-20.) Indeed, for more than a decade, these G-7 countries have displayed similar aggregate R&D trends: substantial

³⁹COSSI agreements will also allow prime contractors to apply their independent R&D funds as a cost-sharing mechanism. See "Independent Research and Development Provides Additional Defense Funding."

⁴⁰The R&D data presented here for the major industrialized countries are obtained from reports to the Organisation for Economic Co-operation and Development (OECD), which is the most reliable source of such international comparisons. A fairly high degree of consistency characterizes the R&D data reported by OECD, with differences in reporting practices among countries affecting their R&D/GDP ratios by no more than an estimated 0.1 percentage point (ISPF 1993). Although R&D data for non-OECD countries are not as widely available and statistically consistent, many of the less developed and former communist countries have made steady improvements over the past few years to make their R&D statistics more internationally comparable. Several such statistics are referenced within this chapter.

⁴¹Some developing countries have greatly expanded the level of national resources they devote to civilian research efforts; nonetheless, the overall financial impact of their efforts is small compared with those of large industrialized countries. For example, South Korea—a country that has made considerable strides in expanding its domestic R&D investment—spends about \$7 billion annually, a figure equivalent to about 3 percent of the U.S. total. For a review of Korea's recent efforts to strengthen its domestic science and technology base, see OECD (1996b).

Purchasing Power Parities: Preferred Exchange Rates for Converting International R&D Data

Comparisons of international statistics on R&D are hampered by the fact that countries' R&D expenditures are denominated, obviously, in their home currencies. Two approaches are commonly used to normalize the data and facilitate aggregate R&D comparisons. The first method is to divide R&D by GDP, which results in indicators of relative effort according to total economic activity. The second method is to convert all foreign-denominated expenditures to a single currency, which results in indicators of absolute effort. The first method is a straightforward calculation, but permits only gross national comparisons. The second method permits absolute-level comparisons and analyses of countries' sector- and field-specific R&D investments, but entails first choosing an appropriate currency conversion series.

Because, for all practical purposes, there are no widely accepted R&D-specific exchange rates, the choice is between market exchange rates and purchasing power parities. These are the only series consistently compiled and available for a large number of countries over an extended period of time.

At their best, MERs represent the relative value of currencies for goods and services that are traded across borders; that is, MERs measure a currency's relative international buying power. But sizable portions of most countries' economies do not engage in international activity, and major fluctuations in MERs greatly reduce their statistical utility. MERs also are vulnerable to a number of distortions—e.g., currency speculation, political events such as wars or boycotts, and official currency intervention—that have little or nothing to do with changes in the relative prices of internationally traded goods.

For these reasons, an alternative currency conversion series—PPPs—has been developed (Ward 1985). PPPs take into account the cost differences across countries of buying a similar basket of goods and services in numerous expenditure categories, including nontradables. The PPP basket is therefore representative of total GDP across countries. When applied to current R&D expenditures of other major performers—Japan and Germany—the result is the same: PPPs result in a substantially lower estimate of total

research spending than do MERs, as shown in figure 4-18 (A). For example, Japan's R&D in 1995 totaled \$76 billion based on PPPs and \$142 billion based on MERs. German R&D was \$38 billion and \$55 billion, respectively. U.S. R&D was \$183 billion in 1995.

PPPs are the preferred international standard for calculating cross-country R&D comparisons and are used in all official OECD R&D tabulations. Although there is considerable difference in what is included in GDP-based PPP items and R&D expenditure items, the major components of R&D costs—fixed assets and the wages of scientists, engineers, and support personnel—are more suitable to a domestic converter than to one based on foreign trade flows. Exchange rate movements bear little relationship to changes in the cost of domestically performed R&D. This point is clearly displayed in figure 4-18 (B) and (C). When annual changes in Japan's and Germany's R&D expenditures are converted to U.S. dollars with PPPs, they move in tandem with such funding denominated in their home currencies. Changes in dollar-denominated R&D expenditures converted with MERs exhibit wild fluctuations unrelated to the R&D purchasing power of those investments. MER calculations indicate that, between 1982 and 1995, German and Japanese R&D expenditures each increased in three separate years by 20 percent or more. In reality, nominal R&D growth never exceeded 14 percent in either country during this period.

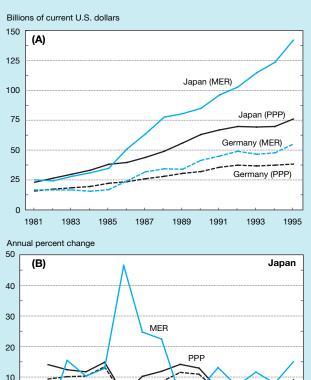
Worse, MER calculations often result in the wrong direction of implied R&D change. Japan reported reductions in nominal yen R&D in 1993 and 1994, but the use of MERs resulted in positive growth rates of 12 and 8 percent, respectively. PPP-denominated R&D was appropriately negative and flat those two years. Conversely, Japan's MER-denominated R&D expenditures declined in 1982, as did Germany's in 1983, 1984, 1989, and 1993. Yet the home currency-denominated R&D expenditures showed positive changes in each of those years. The use of MERs here is obviously inappropriate: PPP calculations result in generally positive annual R&D expenditure changes that are always considerably closer to the countries' actual funding patterns.

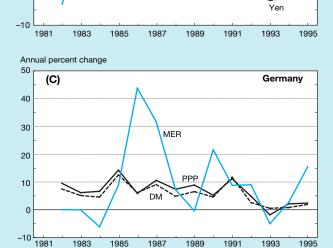
inflation-adjusted R&D growth in the early 1980s, followed by a general tapering off in the late 1980s, then leveling off or declining real R&D expenditures into the 1990s. For most of these countries, economic recessions and general budgetary constraints slowed both industrial and government sources of R&D support; these factors contributed to the major reversal

of positive R&D trends in the United States and Japan, where inflation-adjusted R&D spending declined for three consecutive years beginning in 1992. The same general pattern is true for the United Kingdom and Italy, where real growth in the 1980s gave way to declining R&D expenditures, taking into account overall inflation. Unlike in the United States and Ja-

Figure 4-18.

Japanese and German R&D expenditures and annual changes in R&D estimates





NOTE: DM = deutsche mark; MER = market exchange rate; PPP = purchasing power parity.

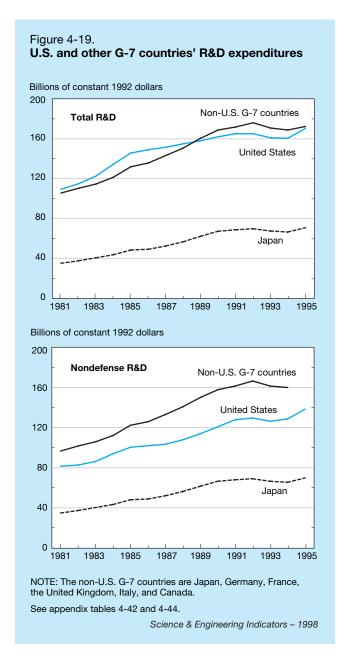
See appendix tables 4-2 and 4-42.

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pan, however, R&D spending in these countries has not recovered to previous levels.

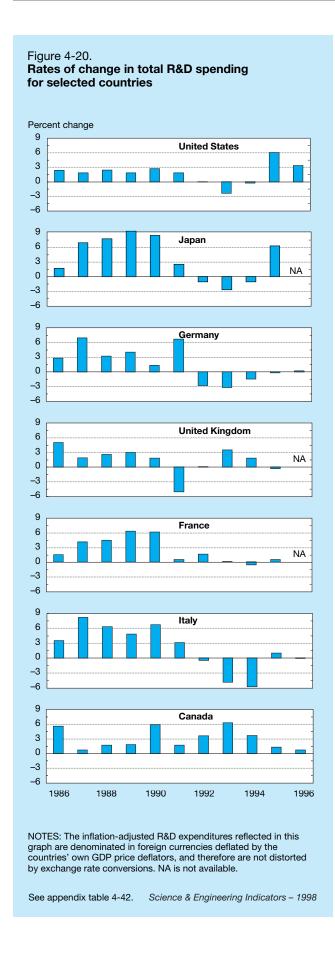
Government Cutbacks in Defense-Related R&D. Additionally, changes in the world's geopolitical climate have led to cutbacks in government support for defense-related R&D. Such reductions, in turn, have slowed reported national



R&D growth patterns in some countries, most notably in the United States, the United Kingdom, and France. For Germany, the integration of the former East German S&T system into the S&T system of West Germany's market economy resulted in an apparent jump in the nation's R&D effort in 1991; it has since been scaled back as a result of the restructuring and closing of inefficient, inappropriate, and redundant research institutions (Government of the Federal Republic of Germany 1993). To date, up to one-third of all former East Germany's R&D institutions have been closed.

Ratio of R&D to GDP

Decreased Ratios in G-7 Countries. The drop in Germany's total R&D effort is indicated by recent trends in its R&D/GDP ratio, one of the most widely used indicators of a country's commitment to growth in scientific knowledge and



technology development. (See figure 4-21.) In Germany, the ratio has fallen from 2.9 percent at the end of the 1980s, before reunification, to its current level of 2.3 percent. This pattern is not, however, restricted to Germany. In fact, the latest R&D/GDP ratio in each of the G-7 countries is no higher now than it was at the start of the 1990s. For example, in the United Kingdom and France, R&D/GDP ratios appear to have drifted back from recent peaks to 2.1 and 2.3 percent, respectively. In Italy and Canada, which also have faced economic and budgetary constraints, the R&D/GDP ratios leveled off at about 1.1 percent and 1.6 percent, respectively.

In the United States, R&D's share of GDP similarly declined from 2.7 percent in 1991 to an estimated 2.4 percent in 1994, before climbing back to an estimated 2.6 percent in 1997. As detailed earlier in the chapter, most of the increase in R&D is due to increased support in the industrial sector, primarily by electrical equipment and transportation equipment companies. (See "Industrial Research and Development.") Similarly in Japan, the R&D/GDP ratio fell from 2.9 percent in 1990 to 2.6 percent in 1994, before rising to 2.8 percent in 1995. ⁴² Both industry and government were responsible for renewed vigor in Japan's R&D spending, with Japan's 1996 Science & Technology Plan suggesting a doubling (in constant yen) of the government's R&D investment by the year 2000 (NSF 1997d). ⁴³

Severe R&D Downsizing Also in Smaller Countries. The likely reversal of funding trends in the United States and Japan notwithstanding, the recent slowdown in R&D spending has not been confined to OECD's largest industrialized countries. R&D growth during the 1990s in many of the smaller or less technologically advanced European countries has been slower than the growth reported for the 1980s. This is particularly true among Eastern European countries and the former Soviet Union, where market economy transitions have necessitated severe market and industrial adjustments, accompanied by even more severe downsizing of R&D activities (European Commission 1994).

The R&D/GDP ratios shown for Russia and several of the former communist states (see figure 4-22) clearly show the overall decline in those countries' indigenous R&D capabilities since the collapse of the Soviet Union. More recent efforts to stabilize the R&D infrastructure are also apparent in the figure. Poland, Hungary, and the Russian Federation each expend roughly 0.75 percent of GDP on R&D activities; for

⁴²The R&D data reported here for Japan generally reflect the official Japanese statistics adjusted by OECD to make them more comparable with international standards. In Japan, data for R&D personnel are expressed as number of people working mainly on R&D rather than as full-time equivalents. Consequently, R&D labor cost data—and therefore total R&D expenditures—are overestimated by international standards. Based on estimates obtained from recent Japanese studies, OECD reports adjusted Japanese R&D totals that are about 15 percent lower than the official R&D series. For example, the adjusted Japan R&D/GDP ratios reported here are 2.1 percent for 1981, 2.9 percent for 1990, and 2.8 percent for 1995. The unadjusted ratios are 2.3 percent for 1981, 3.0 percent for 1990, and 3.0 percent for 1995.

⁴³Although growth in Japanese R&D spending was strongly positive in 1995, more recent problems of overall economic stagnation may foretell another slowing in R&D spending, as was seen in 1992-94, at least by Japanese industrial firms.

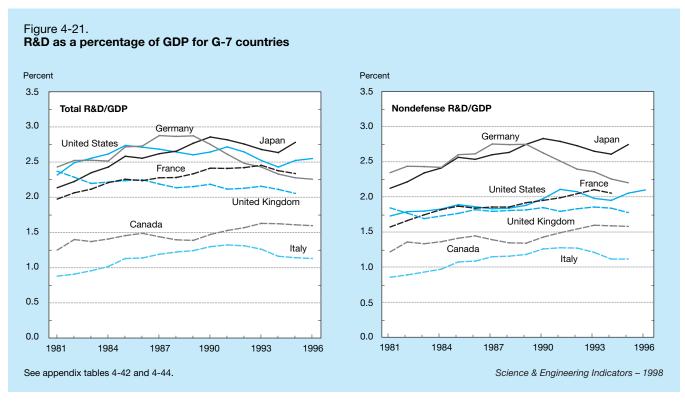


Figure 4-22. R&D as a percentage of GDP for the Russian Federation and Central European countries Percent 2.5 2.0 Czech Republic Russian Federation 1.5 Hungary 1.0 Poland 0.5 0 1990 1991 1992 1993 1994 1995 NOTE: Data are not available before 1991 for the Czech Republic and Hungary and before 1994 for Poland. See appendix table 4-43. Science & Engineering Indicators - 1998

the Czech Republic, the R&D/GDP ratio was about 1.2 percent in 1995.

Notably, whether the overall economy has been growing strongly (as in Poland), modestly (as in Hungary and the Czech Republic), or poorly (as in Russia), R&D expenditures have fallen as a share of GDP. Although these governments appear

strongly motivated to make institutional changes that foster private sector S&T investments, total R&D expenditures continue to falter. This circumstance is partly explained by looking at the composition of industrial activity in these countries. The more successful examples of private sector growth occur in industrial sectors where small businesses often perform better than larger state-owned enterprises (OECD 1996b). Yet such firms seldom have access to resources on a scale large enough to permit heavy R&D investments. Conversely, the larger state-owned enterprises have been more concerned with needed restructuring and downsizing than with expanding their R&D expenditures.

Effects on R&D of Russia's Economic Restructuring. As recently as 1990, R&D accounted for about 2 percent of the USSR's GDP, with about 40 percent of that amount expended on defense-related activities (Gohkberg, Peck, and Gacs 1997). Indeed, the most advanced aspects of Soviet R&D efforts were undertaken in state-owned enterprises devoted to national security; much of the remaining R&D was performed in other large public industrial institutions in applied research fields that overlapped defense concerns. Most of the basic research was and continues to be in engineering fields.

The introduction of a market economy to Russia brought about drastic economic restructuring that saw a sharp fall in the dominance of state-owned enterprises as well as shrinkage in real GDP, down 38 percent from 1991 to 1995. These trends, in turn, brought about major R&D downsizing, with real R&D expenditures in 1995 less than one-fifth of 1990

⁴⁴R&D data for the Russian Federation are taken from Centre for Science Research and Statistics surveys designed to collect such statistics in accordance with OECD international standards.

levels and with an R&D/GDP ratio of about 0.7 percent. Reflecting the lack of core budgets, entire research institutes have been closed—including many well-equipped laboratories of the former military-industrial complex—and an estimated 43 percent of all researchers from 1990 to 1994 left their government R&D laboratories for the commercial sector or retirement or for other reasons, including emigration.

Defense now accounts for about 26 percent of Russia's total R&D, a share comparable to that in the United States. According to statistics released by the Russian Ministry of Science and Technological Policy, overall government R&D budget appropriations now represent about 0.74 percent of GDP, three-fifths of which goes for civilian R&D. In 1991, the comparable figures were 1.85 percent of GDP, one-half of which was civil (CSRS 1997). In real terms, the Russian government's 1994 R&D financing was only one-fourth of that in 1991. As a consequence, business enterprise financing has become increasingly important in the Russian Federation, as has R&D funding from foreign research centers, commercial companies, and international organizations.

Nondefense R&D Trends

Absolute Levels

The policy focus of many governments on economic competitiveness and commercialization of research results has shifted attention from nations' total R&D activities to nondefense R&D expenditures as indicators of scientific and technological strength. Indeed, conclusions drawn about a country's relative standing may differ dramatically depending on whether total R&D expenditures are considered or whether defense-related expenditures are excluded from the totals. In absolute dollar terms, the U.S. international nondefense R&D position is still considerably more favorable than that of its foreign counterparts, but not nearly as dominant as when total R&D expenditures are compared. U.S. civil R&D remains twice that of Japan's, but the non-U.S. G-7 countries' combined total is 18 percent more than nondefense R&D expenditures in the United States alone.

Between 1982 and 1990, growth in U.S. nondefense R&D spending was fairly similar to growth in other industrial countries, save Japan, whose nondefense R&D expenditure growth was notably faster. Thus, as an equivalent percentage of the U.S. nondefense R&D total, comparable Japanese spending jumped from 45 percent in 1982 to 55 percent in 1990. (See appendix table 4-44.) During this period, Germany's annual spending equaled 26 to 29 percent of U.S. nondefense R&D spending, while France's annual spending was equivalent to 17 to 18 percent, and the United Kingdom's annual spending fluctuated narrowly between 15 and 16 percent of the U.S. total.

Since 1990, the worldwide slowing in R&D spending and the subsequent apparent recovery in the United States has narrowed the gap between U.S. nondefense R&D spending and that in the other G-7 countries. In 1995, the combined nondefense R&D spending in these six countries equaled \$163 billion (in constant PPP dollars), compared with \$138 billion (constant dollars) in the United States. Japanese and German spending relative to U.S. spending declined to 50 and 25 percent, respectively.

Ratio of Nondefense R&D to GDP

In normalizing for the size of these economies, the relative position of the United States is slightly less favorable. Japan's nondefense R&D/GDP ratio (2.7 percent) considerably exceeded that of the United States (2.1 percent) in 1995, as it has for years. (See figure 4-21 and appendix table 4-44.) The nondefense R&D ratio of Germany (2.2 percent and declining since a 1989 peak of 2.7 percent) and France (2.1 percent) roughly matched the U.S. ratio; the ratios of the United Kingdom (1.8 percent), Canada (1.6 percent), and Italy (1.1 percent) were somewhat lower. As with total R&D ratios, the nondefense R&D/GDP shares were level or falling in the United States, Germany, and Japan during the early 1990s.

R&D Funding by Source and Performer

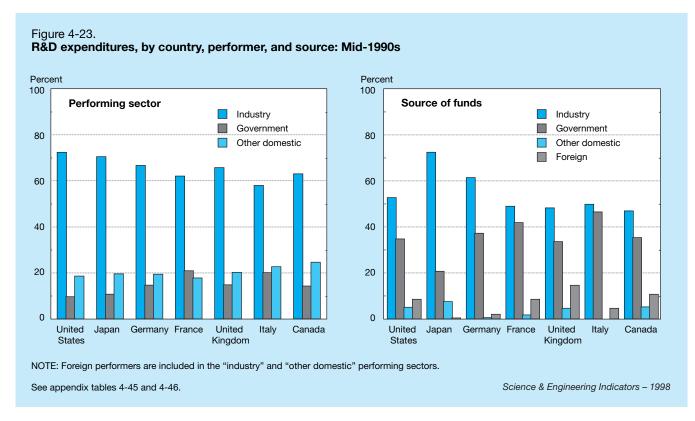
By Performer

The large G-7 countries are markedly similar in terms of which sectors undertake the R&D. Industry was the leading R&D performer in each; performance shares in the mid-1990s ranged from a little more than 70 percent in the United States and Japan, to somewhat less than 60 percent in Italy. Industry's share ranged between 60 and 70 percent in Germany, France, the United Kingdom, and Canada. (See figure 4-23 and appendix tables 4-45 and 4-46.) The majority of industry's R&D performance was funded by industry itself in each of these countries, followed by government funding. Government's share of funding for industry R&D performance ranged from as little as 2 percent in Japan to about 18 percent in the United States.

In most of the G-7 countries, the academic sector was the next largest R&D performer (at about 15 to 22 percent of the performance total in each country), followed by government laboratories. ⁴⁶ Only in France was government's R&D performance (which included spending in several nonprivatized

⁴⁵This is not to say that defense-related R&D does not benefit the commercial sector. Unquestionably, technological spillovers have occurred from defense to the civilian sector. But almost as certainly, the benefits are less than if these same resources had been allocated directly to commercial R&D activities. Moreover, considerable anecdotal evidence indicates that technological flow is now more commonly from commercial markets to defense applications, rather than the reverse.

⁴⁶The national totals for Europe, Canada, and Japan include the research component of general university funds (GUF) block grants provided by all levels of government to the academic sector. Therefore, at least conceptually, the totals include both academia's separately budgeted research and research undertaken as part of university departmental R&D activities. In the United States, the Federal Government generally does not provide research support through a GUF equivalent, preferring instead to support specific, separately budgeted R&D projects. On the other hand, a fair amount of state government funding probably does support departmental research at public universities in the United States. Data on departmental research, considered an integral part of instructional programs, generally are not maintained by universities. U.S. totals may thus be underestimated relative to the R&D effort reported for other countries.



industries and in some sizable government laboratories) slightly larger than that of academia. Government's R&D performance share was smallest in Japan and the United States, at about 10 percent of each country's total.

For comparison, 66 percent of the 5.1 trillion rubles spent on R&D in the Russian Federation in 1994 was performed within business enterprises; 28 percent was undertaken in the government sector, including the Russian Academy of Sciences; and most of the remaining 6 percent was performed in institutions of higher education. Notably, however, it is reported that universities are having difficulty competing with Academy institutes in basic research and with industry in applied R&D; therefore, the higher education sector is gradually losing its position in the overall R&D effort (Gohkberg, Peck, and Gacs 1997).

By Source

Consistent with performing most of these countries' R&D activities, the industrial sector provides the greatest proportion of financial support for R&D. Shares for this sector, however, differed somewhat from one country to the next. Industry provided more than 70 percent of R&D funds in Japan, 60 percent in Germany, and about 50 percent in the United States, the United Kingdom, Italy, France, and Canada.⁴⁷ In each of these seven countries, government was the second largest source of R&D funding and also provided most of the funds used for academic R&D performance.

The R&D funding share represented by funds from abroad

ranged from as little as 0.1 percent in Japan to more than 14 percent in the United Kingdom. Indeed, foreign fundingpredominantly from industry for R&D performed by industry—is an important and growing funding source in several countries. Although its growth pattern has seldom been smooth, foreign funding now accounts for more than 10 percent of industry's domestic performance totals in France, Canada, and the United Kingdom. (See figure 4-24.) Such funding takes on even greater importance in many of the smaller OECD and less industrially developed countries (OECD 1997a). In the United States, approximately 11 percent of funds spent on industry R&D performance in 1995 are estimated to have come from majority-owned affiliates of foreign firms investing domestically. This amount was up considerably from the 3 percent funding share provided by foreign firms in 1980.48 (See appendix table 4-46 and "Foreign R&D in the United States.")

Character of the R&D Effort

The categorization of the R&D effort as either basic research, applied research, or development is quite similar among large, R&D-performing countries for which there are recent data. For several of these countries, however, such

⁴⁷For descriptive statistics on the sectoral composition and size of these OECD countries' industrial R&D activities, see OECD (1997a).

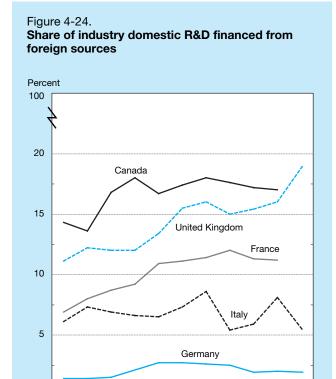
⁴⁸Unlike for other countries, there are no data on foreign sources of U.S. R&D performance. The figures used here to approximate foreign involvement are derived from the estimated percentage of U.S. industrial performance undertaken by majority-owned (i.e., 50 percent or more) nonbank U.S. affiliates of foreign companies. In short, the U.S. foreign R&D totals represent industry funding based on foreign *ownership* regardless of originating source, whereas the foreign totals for the other countries represent *flows* of foreign funds from outside the country to any of its domestic performers.

1985

See appendix table 4-49.

1987

1989



comprehensive national statistics either are not collected or are considerably out of date. As documented earlier in the chapter, the United States expends about 15 percent of its R&D on activities that performers classify as basic research. (See discussion on basic research in "R&D Support and Performance by Character of Work," earlier in this chapter.) Much of this research is in the life sciences. Basic research accounts for a similar portion of the R&D total in Japan and the Russian Federation—14 percent and 16 percent, respectively. (See figure 4-25.) However, as a share of domestic basic research totals, engineering fields receive relatively more funding in these two countries than in the United States. In France and Germany, the basic research share represented about 21 to 22 percent of the R&D total in the mid-1990s (OECD forthcoming). In each of these countries, development activities accounted for the largest percentage share of total.

Japan

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1993

1995

1991

International Comparisons of Government R&D Priorities

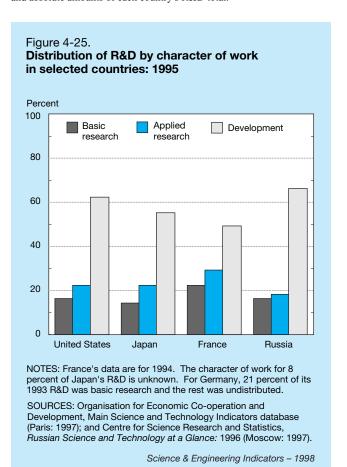
The downturn in R&D growth within OECD countries has been disproportionately caused by negative or near-zero growth in government-funded R&D since the late 1980s. These developments are both a reflection of and an addition to the worldwide R&D landscape changes. Such changes are presenting a variety of new challenges and opportunities. The transition of Eastern European communist systems into market economies, the growth of the S&T base in the Pacific

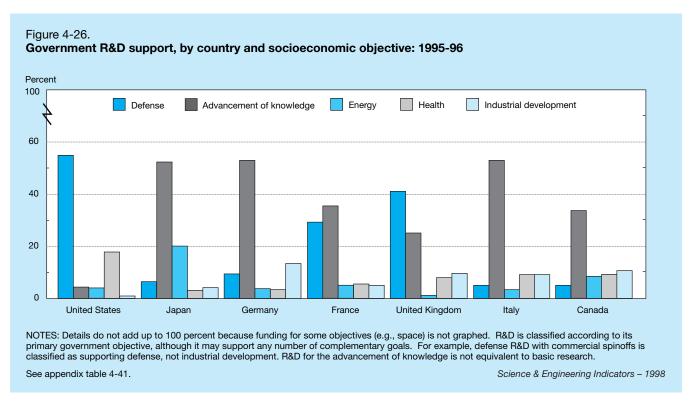
Rim, the increase in the international competitiveness of many countries, public and private sector demands for budgetary accountability, evolution of new and emerging technologies, and realignments within industry and at research universities have combined to present governments with historically unparalleled issues of purpose and direction in designing S&T policy. The following sections highlight government R&D funding priorities in several of the larger R&D-performing nations, summarize broad policy trends, and detail indirect support for research that governments offer their domestic industries through the tax code.

Funding Priorities by National Objective

A breakdown of public expenditures by major socioeconomic objectives provides insight into governmental priorities, which differ considerably across countries.⁴⁹ In the United States during 1996, 55 percent of the Government's \$69 bil-

⁴⁹Data on the socioeconomic objectives of R&D funding are rarely obtained by special surveys, but rather are generally extracted in some way from national budgets. Since these budgets already have their own methodology and terminology, these R&D funding data are subject to comparability constraints not placed on other types of international R&D data sets. Notably, although each country adheres to the same criteria for distributing their R&D by objective, as outlined in the OECD's Frascati Manual (1994), the actual classification may differ among countries because of differences in the primary objective of the various funding agents. Note also that these data are of government R&D funds only, which account for widely divergent shares and absolute amounts of each country's R&D total.





lion R&D investment was devoted to national defense; compared with 41 percent in the United Kingdom (of an \$8 billion government total); 29 percent in France (of \$13 billion); and 10 percent or less each in Germany, Italy, Canada, and Japan. (See figure 4-26 and appendix table 4-41.) These recent figures represent substantial cutbacks in defense R&D in the United States, the United Kingdom, and France, where defense accounted for 63 percent, 44 percent, and 40 percent of government R&D funding, respectively, in 1990. However, defense-related R&D also seems particularly difficult to account for in many countries' national statistics. (See "Accounting for Defense R&D: Discrepancies Between Performer- and Source-Reported Expenditures.")

Different Countries' R&D Emphasis

Advancement of Knowledge. Japanese, German, and Italian government R&D appropriations in 1995-96 were invested relatively heavily (50 percent or more of the \$15 billion totals for Japan and Germany, and of the \$6 billion total in Italy) in advancement of knowledge—i.e., combined support for advancement of research and general university funds (GUF). Indeed, the GUF component of advancement of knowledge, for which there is no comparable counterpart in the United States, represents the largest part of government R&D expenditure in most of these OECD countries.⁵⁰

Health-Related Research. The emphasis on health-related research is much more pronounced in the United States than in other countries. This emphasis is especially notable in the support of life sciences in academic and similar institutions. In 1996, the U.S. Government devoted 18 percent of its R&D investment to health-related R&D, making such activities second only to defense. (See "Patterns of Federal R&D Support.") Health R&D support approaches 10 percent of total spending in the governmental R&D budgets of the United Kingdom, Italy, and Canada.

Other Areas of R&D Emphasis. In comparison, Japan committed 20 percent of governmental R&D support to energy-related activities, which garnered the second largest share of Japanese R&D, reflecting the country's historical concern with its high dependence on foreign sources of energy. In Canada, 14 percent of the government's \$3 billion in R&D funding was directed toward agriculture. Space R&D received

other than the United States, governments support academic research primarily through large block grants that are used at the discretion of each individual higher education institution to cover administrative, teaching, and research costs. Only the R&D component of GUF is included in national R&D statistics, but problems arise in identifying the amount of the R&D component and the objective of the research.

Government GUF support is in addition to support provided in the form of earmarked, directed, or project-specific grants and contracts (funds for which can be assigned to specific socioeconomic categories). In the United States, the Federal Government (although not necessarily state governments) is much more directly involved in choosing which academic research projects are supported than in Europe and elsewhere. Thus, these socioeconomic data are indicative not only of relative international funding priorities, but also of funding mechanisms and philosophies regarding the best methods for financing research. For the 1995-96 period, the GUF portion of total national governmental R&D support was between 38 and 45 percent in Japan, Italy, and Germany; it was between 16 and 20 percent in the United Kingdom, Canada, and France.

⁵⁰In the United States, advancement of knowledge is a budgetary category for research unrelated to a specific national objective. Furthermore, whereas GUF is reported separately for Japan, Canada, and European countries, the United States does not have an equivalent GUF category: funds to the university sector are distributed to address the objectives of the federal agencies that provide the R&D funds. The treatment of GUF is one of the major areas of difficulty in making international R&D comparisons. In many countries

Accounting for Defense R&D: Discrepancies Between Performer- and Source-Reported Expenditures

In many OECD member countries, including the United States, there is a considerable difference in the total government R&D support figures reported by government agencies and those reported by performers of the R&D work. Consistent with international guidance and standards (OECD 1994), however, most countries' national R&D expenditure totals and time series are based primarily on data reported by performers. This convention is preferred because performers are in the best position to indicate how much they spent in the actual conduct of R&D in a given year, and to identify the source of their funds. Although there are many reasons not to expect the funding and performing series to match exactly—e.g., different bases used for reporting government obligations (FY) and performance expenditures (calendar year)—the gap between the two R&D series has widened during the past several years in several of the larger OECD member countries. Additionally, the divergence in the series is most pronounced in countries with relatively large defense R&D expenditures.

For 1995 or thereabouts, statistics from OECD's Main Science and Technology Indicators database show that in only 6 of the 28 member countries does defense account for 9 percent or more of government's total R&D budget (because several OECD member countries have never or not recently reported their R&D defense shares, funding differences in those countries could not be evaluated):

- ♦ United States (54 percent),
- ♦ United Kingdom (41 percent),
- ♦ France (30 percent),
- ♦ Sweden (21 percent),
- ♦ Spain (10 percent), and
- ♦ Germany (9 percent).

These six were precisely the countries for which the sums of performer-reported government R&D funding were substantially less than the total government-reported R&D support estimates. As a percentage of government's reported R&D totals that were not accounted for in each country's performer surveys, the largest gaps were reported for:

- ♦ Sweden (20.4 percent government R&D "leakage"),
- ♦ France (18.4 percent),
- ◆ United Kingdom (13.0 percent),

- ◆ Spain (9.8 percent),
- ◆ United States (8.2 percent—taken from national sources, not OECD databases), and
- ♦ Germany (7.5 percent).

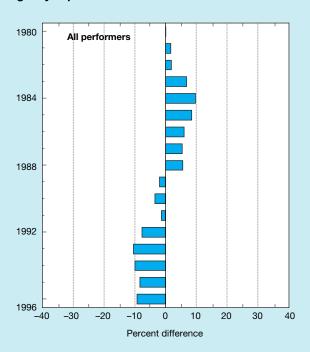
For the United States, the funding gap has become particularly acute over the past several years. In the mid-1980s, performer-reported federal R&D exceeded federal reports by \$3 to \$4 billion annually, or 5 to 10 percent of the government total. This pattern reversed itself so that in 1989 the government-reported R&D total exceeded performer reports by \$1 billion. The gap has since grown to about \$6 billion; in other words, about 10 percent of the government total in the mid-1990s is unaccounted for in performer surveys. (See figure 4-27 and appendix table 4-47.)

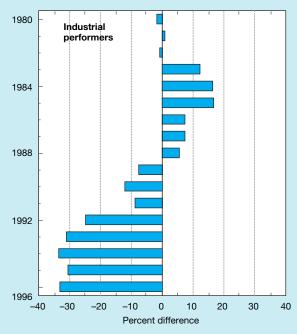
Based on preliminary findings, the difference in federal R&D totals appears to be concentrated primarily in DOD development funding of industry (primarily aircraft and missile firms). For 1995, federal agencies reported \$30.5 billion in total R&D obligations *provided* to industrial performers, compared with an estimated \$21.2 billion in federal funding *reported* by industrial performers. (DOD reports industry R&D funding of \$22.7 billion, while industry reports using \$13.9 billion of DOD's R&D funds.) Overall, governmentwide estimates equate to a "loss" of 31 percent of federally reported R&D support. (See figure 4-27 and appendix table 4-47.)

A workshop was held recently at NSF (September 1997) to discuss possible causal factors for the divergence. Although circumstances unique to each country contribute to the discrepancy between the two reporting sources, most participants agreed that the problem resides at least partially in reporting R&D for defense and aerospace programs and in tracking government's international R&D flows. In the case of defense and aerospace programs, workshop participants acknowledged possible differences in agency and performer reporting of "the true R&D content" of large extramural contracts where R&D and production activities are mixed. This circumstance is further complicated by the growing use of industry subcontracting and consortia activities in performing large-scale and complex defense projects. For many European countries, these activities are also collaborative and are performed internationally, so that the final R&D performers may be unable to accurately report the origin of the funds. The Science Resources Studies Division at NSF is conducting further research and investigation into these causal phenomena.

Figure 4-27.

Difference in U.S. performer-reported versus agency-reported federal R&D





NOTE: Difference is defined as the percentage of federally reported federal R&D support.

See appendix table 4-47.

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considerable support in the United States and France (each getting 11 percent of the total), whereas industrial development accounted for 9 percent or more of governmental R&D funding in Germany, the United Kingdom, Italy, and Canada. Industrial development programs accounted for 4 percent of the Japanese total, but just 0.6 percent of U.S. R&D. The latter figure is understated relative to other countries as a result of data compilation differences.

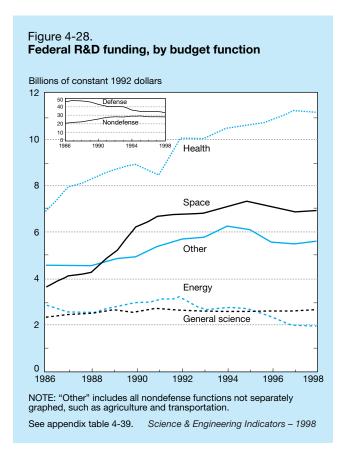
Government R&D Trends in the United States

This section provides greater detail on federal R&D funding priorities in the United States. Such priorities shifted overwhelmingly toward defense programs in the 1980s, which included both DOD programs and nuclear weapons research funded by DOE. Defense R&D spending peaked in 1987 at \$47 billion (inflation-adjusted 1992 dollars), when it accounted for 69 percent of the federal R&D total. Since then, the data reflect a distinct de-emphasis on defense priorities, as defense-related R&D dropped to 54 percent of the government total in 1995, where it has since remained. (See figure 4-28 and appendix table 4-39.) Proposed federal R&D funding for defense-related activities accounts for 54 percent of the 1998 total.

Of the federal nondefense functions, health—particularly the R&D programs of HHS—experienced the largest inflation-adjusted R&D funding growth since the early 1980s. Indeed, from 1990 to 1998, health R&D has grown by 26 percent (constant 1992 dollars) while funding for all other nondefense functions grew by just 3 percent. Health programs now account for 18 percent of the federal R&D funding total. In particular, AIDS-related research has grown substantially and now accounts for roughly 12 percent of federal health R&D funds, second only to the 16 percent share directed toward cancer research. Funding for space research, second to health among the nondefense functions in the United States, also grew rapidly in the late 1980s and now accounts for 11 percent of the Federal Government R&D total. Most of the R&D funding growth in this area has been in support of Space Station Freedom and its follow-on International Space Station activities.⁵²

⁵¹The Office of Management and Budget classifies all activities within the federal budget into 20 functional categories. The budget function classification system provides a means to classify budgetary resources according to the national need being addressed. Fifteen functions contain federal R&D programs. For definitions and details, see NSF (1997c). Data reported here reflect estimates for R&D programs contained in the Administration's 1998 budget proposal submitted to Congress in January 1997 (U.S. OMB 1997). Notably, each specific activity is assigned to only one object code so that programs with multiple objectives will be classified only once under the program's primary functional objective. For example, except for those of the Army Corps of Engineers, all R&D activities sponsored by DOD are classified as defense, even though some activities have secondary objectives such as health, space, or commerce (i.e., defense and commercial dual-use applications). Consequently, these totals are indicative of trends but are not necessarily conclusive. See the recent GAO report for coverage of the Federal Government's total funding by function (U.S. GAO 1997b).

⁵²Funding for the Space Station rose from \$22 million in 1984, the first year for which this program received a separate budget line item, to \$2.1 billion in 1997 (AAAS 1997).



Among the other major functional recipients of federal R&D funding, general science programs⁵³ displaced energy activities as the third largest nondefense function in 1996, even though in constant dollars general science research funding is proposed to be no higher in 1998 than it was in 1992. Combined, defense plus these four nondefense functions account for 91 percent of proposed 1998 R&D budget authority.

In terms of *basic* research support, these five functions also account for a 91 percent share of the federal support total, but their relative rankings differ considerably from that for total R&D. (See appendix table 4-40.) Of the proposed \$15.3 billion 1998 basic research budget authority, health functions (primarily programs of the National Institutes of Health) account for 46 percent; the general science programs of NSF and DOE for 19 percent; space functions for 10 percent; energy for 9 percent; and defense for 8 percent.

International Comparisons of Government Policy Trends

These aggregate funding priority data only begin to capture the extraordinary changes that have taken place in the international arena over the past several years and the resultant shifts in countries' S&T policy directions. According to a recent OECD (1996) report, a number of common trends among countries are worth highlighting:

- ♦ Despite the need to limit public sector expenditures and reduce public sector deficits, support for R&D has remained a priority of public policy throughout OECD member countries. Some countries, such as Japan, have recently announced their intention to increase public sector R&D funding.
- ♦ Budgetary restrictions on research funding have led to a growing emphasis on ensuring the efficient use of resources through more extensive program and policy evaluation.
- Many countries are focusing R&D support on specific technologies such as information technologies, energy and environmental technologies, biotechnology, and advanced materials.
- ◆ To foster international competitiveness, governments have maintained and expanded measures to strengthen the links between science and industry by establishing initiatives that increase collaboration between higher education and business sectors and between government agencies and industry.
- ◆ Many OECD countries have determined that fiscal measures to support industrial R&D represent an important component of public policy aimed at increasing overall R&D and stimulating industrial innovation.

International R&D Tax Treatment

Tax treatment of R&D in OECD countries is broadly similar, with some variations in the use of R&D tax credits (OECD 1996a). The following are main features of the R&D tax instruments:

- ◆ Practically all countries (including the United States) allow industry R&D expenditures to be 100 percent deducted from taxable income in the year they are incurred.
- ♦ In most countries, R&D expenditures can by *carried forward* or deducted for some 3 to 10 years. (In the United States, there is a 3-year carry-forward on R&D expenditures and a 15-year carry-forward on R&D capital assets).
- ♦ About half the countries (including the United States—see below) provide some type of additional R&D tax credit or incentive, with a trend toward using incremental credits and more targeted approaches such as those favoring basic research.
- ◆ Several countries have special provisions that favor R&D in small and medium-size enterprises. (In the United States, special credit provisions exist for small startup firms, but more direct federal R&D support is provided through grants to small firms. See "SBIR Program Expands Support for Small Business R&D.")
- ♦ There are a growing number of R&D tax incentives being offered at the subnational (provincial and state) levels, including in the United States (see below).

⁵³Research activities classified under this "general science" budget category are seen as contributing more broadly to the nation's science and engineering base than do basic research programs that support agency missions.

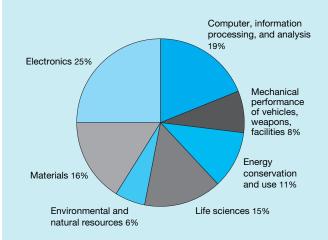
SBIR Program Expands Support for Small Business R&D

The Small Business Innovation Research (SBIR) Program was created in 1982 to strengthen the role of small firms in federally supported R&D. Since that time, the SBIR Program has directed nearly 37,000 awards worth more than \$5.5 billion in R&D support to thousands of qualified small high-tech companies on a competitive basis. Under this program, which is coordinated by the Small Business Administration (SBA) and is in effect until the year 2000, when an agency's external R&D obligations (those exclusive of in-house R&D performance) exceed \$100 million, the agency must set aside a fixed percentage of such obligations for SBIR projects. This percentage initially was set at 1.25 percent, but under the Small Business Research and Development Enhancement Act of 1992, it rose incrementally to 2.5 percent in 1997.

To obtain funding, a company applies for a Phase I SBIR grant. The proposed project must meet an agency's research needs and have commercial potential. If approved,

Figure 4-29.

Small Business Innovation Research awards, by technology area: 1983-95



SOURCE: U.S. Small Business Administration, Small Business Innovation Development Act (Washington, DC: 1997).

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grants of up to \$100,000 are made to allow the scientific and technical merit and feasibility of an idea to be evaluated. If the concept shows potential, the company can receive a Phase II grant of up to \$750,000 to develop the idea further. In Phase III, the innovation must be brought to market with private sector investment and support. No SBIR funds may be used for Phase III activities.

Eleven federal agencies participated in the SBIR Program in 1995, making awards totaling \$865 million—an amount equivalent to 1.3 percent of all government R&D obligations. The total amount obligated for SBIR awards in 1995 was 30 percent more than in 1994, a result of legislatively required increases in R&D amounts agencies must earmark for SBIR. Whereas 71 percent of the *grants* awarded were Phase I grants (3,085 of 4,348 awards in 1995), roughly 70 percent of total SBIR *funds* were disbursed through Phase II grants. Approximately 48 percent of all SBIR obligations were provided by DOD, mirroring this agency's share of the federal R&D extramural funding total. (See appendix table 4-37.)

There have not been many assessments of the overall effectiveness of the SBIR Program, although it is generally agreed that the quality of funded research proposals is high. For example, GAO (1997c) reports that about one-half of surveyed DOD SBIR awards have led to sales of a product, process, or service; about 52 percent of these sales have been made to DOD or to its prime contractors, with remaining sales to private sector customers or others.

SBA classifies SBIR awards into various technology areas. In terms of all SBIR awards made during the 1983-95 period, the technology area receiving the largest (value) share of Phase I awards was advanced materials. Electronics device performance and computer communications systems were the leading technology areas for Phase II awards. More broadly, roughly one-fifth of all awards made from 1983 to 1995 were computer-related and one-fourth involved electronics. (See figure 4-29.) Each received more than 70 percent of its support from DOD and NASA. One-sixth of SBIR awards went to life sciences research, with the bulk of this funding provided by HHS.

U.S. Federal and State R&D Tax Credits

Credits Provided by the Federal Government. As have many other countries, the U.S. Government has tried policy instruments in addition to direct financial R&D support to indirectly stimulate corporate research spending. The most notable of these efforts has been to offer tax credits on incremental research and experimentation (R&E) expenditures.⁵⁴

The credit was first put in place in 1981 and has been renewed eight times, most recently through the end of May 1998. ⁵⁵ Although the computations are complicated, the tax code provides for a 20 percent credit for a company's qualified

⁵⁴Not all R&D is eligible for such credit, which is limited to expenditures on laboratory or experimental R&D.

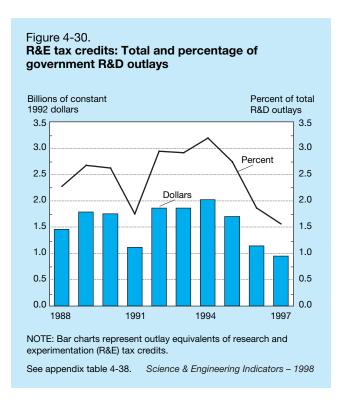
⁵⁵In its latest extension, the credit was renewed in August 1997 retroactive to June 1997. The credit had lapsed from mid-1995 to mid-1996 before being restored in 1996 to a modified form. See also Poterba (1997) for a discussion of international elements of corporate R&D tax policies.

R&D amount that exceeds a certain threshold.⁵⁶ Since 1986, companies have been allowed to claim a similar credit for basic research grants to universities and other qualifying nonprofit institutions, although the otherwise deductible R&E expenditures are reduced by the amount of the basic research credit. This basic research provision generally has gone unutilized.⁵⁷

The dollar value of R&E tax credits actually received by firms is unknown. Not all of the tax credits initially claimed by firms are allowed. Indeed, data from the Internal Revenue Service indicate that in any given tax year, this dollar value can be 20 to 30 percent less than the amount for which firms file claims—nearly \$1.6 billion in 1992, the most recent year for which data are available (U.S. OTA 1995). This amount has fluctuated since the credit's inception in 1981, but has remained rather steady since 1988. (See appendix table 4-38.)

Additionally, as part of the federal budget process, Treasury annually calculates estimates of foregone tax revenue (tax expenditures) resulting from preferential tax provisions, including the R&E tax credit. As one measure of budgetary effect, Treasury provides outlay-equivalent figures that allow a comparison of the cost of this tax expenditure with the cost of a direct federal R&D outlay. Between 1981 and 1996, more than \$27 billion was provided to industry through this indirect means—an amount equivalent to about 3 percent of direct federal R&D support. (See figure 4-30 and appendix table 4-38.)

Effectiveness of Credits Uncertain. Results of various studies undertaken since the mid-1980s have given the tax credit mixed reviews for its overall effectiveness. Assessments undertaken soon after initial enactment of the credit (those using data for the years 1981 to 1983) concluded that the R&E tax credit cost more in lost revenues than it produced in additional R&E expenditures. More recent and somewhat more comprehensive studies (using data for the years 1988 and later) indicate that the amount of induced R&E spending approximates revenue cost in the short term and exceeds it in the long term (U.S. OTA 1995 and U.S. GAO 1996c).⁵⁸ Although some firms rely heavily on the credit—e.g., industries with rapidly expanding R&D outlays (as in communications and information technology) and industries for which R&D



performance strongly affects market valuation (as in biotechnology)—preliminary evidence indicates that the R&E tax credit rarely factors into individual firms' R&D planning processes. There are no studies that have empirically investigated the credit's net benefit to society.

Credits Provided by State Governments. The Federal Government is not the only source of fiscal incentives for increasing research. According to a recent survey of the State Science and Technology Institute (1997), 35 states offered some type of incentive for R&D activity in 1996. Many states offered an income tax credit modeled after the federal R&E credit guidelines. Fifteen states applied the federal research tax credit concepts of qualified expenditures or base years to their own incentive programs, although they frequently specified that the credit could only be applied to expenditures for activities taking place within the state. Other types of R&D incentives included sales and use tax credits and property tax credits.

Internationalization of R&D and Technology

Globalization of R&D activities has expanded considerably during the past two decades. This growth is exhibited in each of the R&D-performing sectors. Gains in cross-country academic research collaboration are indicated by the substantial increase in international coauthorships. (See chapter 5, "Trends in International Article Production.") In the public sector, the rapid rise in international cooperation has spawned activities that now account for up to 10 percent of government R&D expenditures in some countries. International collaboration in scientific research involving extremely large "megascience" projects also has grown, reflecting scientific and budgetary realities. Excellent science is not the domain of any single country, and many scientific problems involve

⁵⁶The complex base structure for calculating qualified R&D spending was put in place by the Omnibus Reconciliation Act of 1989. With various exceptions, a company's qualifying threshold is the product of a fixed-base percentage multiplied by the average amount of the company's gross receipts for the four preceding years. The fixed-base percentage is the ratio of R&E expenses to gross receipts for the increasingly distant 1984-88 period. Special provisions cover startup firms.

⁵⁷In 1992, firms applying for the R&E credit spent about \$1 billion on research performed by educational and scientific organizations, of which—after various qualification restrictions—the basic research credit contributed less than \$200 million toward the R&E tax credit (U.S. OTA 1995).

⁵⁸Whatever its ultimate impact on R&D spending, the tax credit has certainly influenced spending less than it could have, were it less subject to erratic legislative treatment. The tax credit has had to be repeatedly (almost annually) renewed, its calculation provisions have changed considerably over the years, and it was even allowed to lapse several times—circumstances that created considerable uncertainty for businesses that otherwise would have planned to take the credit.

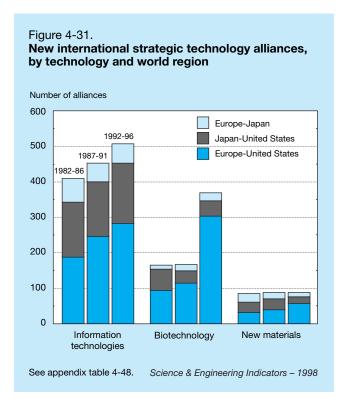
major instrumentation and facility costs that appear much more affordable when cost-sharing arrangements are in place. Additionally, some scientific problems, such as global change research, demand an international effort.

In the private sector, international R&D collaboration is also on the rise, as is indicated by the growth of formal cooperative partnerships between firms. Growing international linkages are evidenced as well by the rise of overseas R&D activities performed under contract and through subsidiaries, and by the establishment of independent research facilities. Although the reasons for this growth are complex, multilateral industrial R&D efforts appear to be a response to the same competitive factors affecting all industries: rising R&D costs and risks in product development, shortened product life cycles, increasing multidisciplinary complexity of technologies, and intense foreign competition in domestic and global markets.

International Strategic Technology Alliances

Industrial firms increasingly have sought global research partnerships as a means of strengthening their core competencies and expanding into technology fields considered critical for maintaining market share. Such international strategic technology alliances increased sharply throughout the industrialized world in the early 1980s and accelerated as the decade continued.⁵⁹ Although growth of newly established alliances tapered off in the early 1990s, there is evidence of further expansion during the middle part of this decade. Formation of these strategic technology partnerships has been particularly extensive among high-tech firms in such core areas as information technologies, biotechnology, and new materials. (See figure 4-31 and appendix table 4-48.) Technological complementarity and reduction of the innovation period are primary catalysts for entering into core technology alliances; market entry and production-related factors are more relevant in technologically less advanced or more mature markets.

CATI is a literature-based database; its key sources are newspapers, journal articles, books, and specialized journals that report on business events. CATI's main drawbacks and limitations are that (1) data are limited to activities publicized by the firm, (2) agreements involving small firms and certain technology fields are likely to be underrepresented, (3) reports in the popular press are likely to be incomplete, and (4) it probably reflects a bias because it draws primarily from English-language materials. CATI information should therefore be viewed as indicative and not comprehensive.



Nature of Cooperative Activity Changing

As the numbers have increased, the forms of cooperative activity have changed as well. The most prevalent modes of global industrial R&D cooperation in the 1970s were joint ventures and research corporations. In these arrangements, at least two companies share equity investments to form a separate and distinct company; profits and losses are shared according to the equity investment. In the second half of the 1980s and continuing into the 1990s, joint nonequity R&D agreements became the most important form of partnership. Under such agreements, two or more companies organize joint R&D activities to reduce costs and minimize risk, while pursuing similar innovations. Participants share technologies but have no joint equity linkages (Hagedoorn 1990 and 1996).

Growth in Core Technology Alliances

During the first half of the 1970s, strategic alliances were almost nonexistent in core technologies, as well as in other sectors, but expanded rapidly late in the decade. The number of newly made partnerships in the three core technologies—information technologies, biotechnology, and new materials—rose from about 10 alliances created in 1970 to about 140 in 1980 (Hagedoorn 1996). By 1986, this number had risen to 400 alliances, 250 of which were intraregional (that is, made between firms located in the same broad regions of Europe, Japan, or the United States); 150 were interregional (between firms located in separate regions). The majority of both types of alliances was between

⁵⁹Information in this section is drawn from an extensive database compiled in the Netherlands (MERIT-CATI—Maastricht Economic Research Institute on Innovation and Technology's Cooperative Agreements and Technology Indicators database) on more than 10,000 inter-firm cooperative agreements involving thousands of different parent companies. In the CATI database, only agreements that contain arrangements for transferring technology or joint research are collected. The data summarized here extend by three years the information for 1970 to 1993 presented in Hagedoorn (1996). These counts are restricted to strategic technology alliances, such as joint ventures for which R&D or technology sharing is a major objective, research corporations, joint R&D pacts, and minority holdings coupled with research contracts.

⁶⁰Joint ventures are companies that have shared R&D as a specific company objective, in addition to production, marketing, and sales. Research corporations are joint R&D ventures with distinctive research programs.

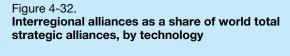
firms sharing information technologies such as computer software and hardware, telecommunications, industrial automation, and microelectronics.

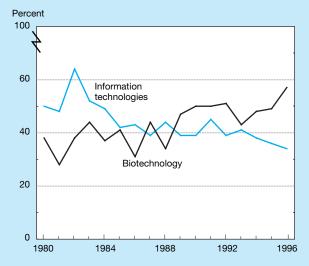
For the decade since 1986, growth in core technology alliances has been continuous though irregular. Of the roughly 2,500 information technology alliances formed during this period, the largest number has been among U.S. companies and between European and U.S. firms. Among the 1,100 strategic biotechnology alliances, U.S.-European interregional partnerships have been more prevalent than any other, especially during the mid-1990s. In fact, by 1996 almost 60 percent of all biotechnology collaborations were interregional. The opposite was true of partnerships focusing on information technology, for whom intraregional alliances were created twice as often as interregional partnerships in 1996. (See figure 4-32.)

U.S. Industry's International R&D Investment Balance

Stiff international competition in research-intensive, high-technology products, along with market opportunities, have compelled firms throughout the world to expand their overseas research activities. Foreign sources account for a growing share of domestic R&D investment totals in many countries (see figure 4-24), and many firms have R&D sites in countries outside of their home base. (See "U.S. Research Facilities of Foreign Firms" for a summary of recent statistics on foreign R&D sites in the United States.) Firms tend to adopt a global approach to R&D for one of two basic reasons:

1. Multinational firms seek a foreign R&D presence to sup-





NOTE: Interregional alliances include those between the United States and Europe, the United States and Japan, and Europe and Japan.

See appendix table 4-48. Science & Engineering Indicators – 1998

- port their overseas manufacturing facilities or to adapt standard products to the demand there. This arrangement constitutes a *home-base exploiting* site, where information tends to flow to the foreign laboratory from the central home laboratory.
- The foreign site is established to tap knowledge from competitors and universities around the globe, constituting a *home-base augmenting* site, where information tends to flow from the foreign laboratory to the central home laboratory.

According to a recent study of 238 foreign R&D sites, 45 percent of the labs were home-base augmenting and 55 percent were home-base exploiting (Kuemmerle 1997).⁶¹

U.S.-Foreign Industrial R&D Flows

U.S. companies' R&D investment abroad is roughly equivalent to R&D expenditures in the United States by majorityowned U.S. affiliates of foreign companies. 62 In 1994 (the latest year for which complete data from the Bureau of Economic Analysis—BEA—are available), industrial R&D flows into the United States totaled \$12.7 billion, compared with the \$11.5 billion in R&D expenditures by U.S. multinational firms in other countries. (See figure 4-33.) This approximate balance in R&D investment flows has persisted since 1989 when the majority-owned data first became available on an annual basis. However, a general shift has occurred in the aggregate "balance" of R&D flows over this period. In the early 1990s, a greater proportion of international R&D was spent abroad than was invested in the United States. It now appears the reverse is true, and more industrial R&D money is flowing into the United States than U.S. firms are investing abroad.

Europe is both the primary source and the main destination of these U.S.-foreign industrial R&D flows. (See figure 4-34.) European firms invested \$11.6 billion of R&D money in the United States in 1995; the Asian (including the Middle East) and Pacific region provided the second largest source of foreign R&D funds, with \$1.6 billion. Similarly, U.S. companies invested \$8.3 billion of R&D in Europe and \$1.9 billion in Asian and Pacific region investments. Bilateral R&D

⁶¹The terms "home-base exploiting" and "home-base augmenting" are taken directly from Kuemmerle (1997). However, others (notably Mowery 1997) have made similar observations on the reasons for the expanding global R&D arrangements. Furthermore, Mowery notes that the use of international R&D strategies to establish networks for the creation and strengthening of firm-specific technological capabilities (that is, home-base augmenting) is likely to become more important than market exploitation-driven activities in the future.

⁶²These overseas R&D data are from the U.S. Bureau of Economic Analysis (BEA) survey on U.S. Direct Investment Abroad. The definition used by BEA for R&D expenditures is from the Financial Accounting Standards Board Statement No. 2; these expenditures include all charges for R&D performed for the benefit of the affiliate by the affiliate itself and by others on contract. BEA detail is available for 1982 and annually since 1989. Data on foreign sources of industrial R&D performed in the United States come from an annual survey of Foreign Direct Investment in the United States, also conducted by BEA. BEA reports that foreign R&D totals are comparable with U.S. R&D business data published by NSF. Industry-specific comparisons, however, are limited because of differences in the industry classifications used by the two surveys (Quijano 1990).

U.S. Research Facilities of Foreign Firms

Consistent with the worldwide trend of multinational firms establishing an R&D presence in multiple countries, considerable growth has occurred in R&D facilities being operated by foreign companies in the United States. According to a 1992 survey of 255 foreign-owned freestanding R&D facilities in the United States, about half were established during the previous six years (Dalton and Serapio 1993). These counts are only for those R&D facilities that are 50 percent or more owned by a foreign parent company.* In a recent update to this study (Dalton and Serapio 1998), the authors characterize the activities of 676 U.S. R&D facilities run by more than 350 European, Japanese, and other foreign companies. Significant findings of this study follow:

♠ R&D facilities owned by Japanese firms continue to far outnumber those of all other countries. Japanese companies owned 244 R&D facilities in the United States in 1996, British companies owned 102, German companies owned 93, and French and Swiss companies each owned more than 40. (See text table 4-10.) South Korean companies have a rapidly growing pres-

- ence in the United States, owning 32 R&D facilities here in 1996—6 more than had been identified in 1994, and about 20 more than listed for 1992.
- ◆ The activities of these foreign facilities were highly concentrated in several industries: drugs and biotechnology (111 facilities), chemicals and rubber (110), computers and computer software (88), food and consumer goods (61), high-definition television and other electronics (59), instruments and medical devices (52), and automotive products (50). Japanese companies account for most of the R&D centers in the electronics and automotive industries, while European companies have far more R&D sites focusing on pharmaceuticals and chemicals.
- ◆ Foreign R&D facilities were heavily concentrated in selected areas of the country, notably California's Silicon Valley and greater Los Angeles, Detroit, Boston, Princeton, and North Carolina's Research Triangle Park.

The most important reasons cited for Japanese foreign electronics R&D investment in the United States were to acquire technology and to keep abreast of technological developments (a home-base augmenting strategy). For automotive R&D, investment motives centered on assisting the parent company in meeting U.S. environmental regulations and customer needs (a home-base exploiting strategy).

Text table 4-10.

U.S. R&D facilities of foreign companies, by selected industry and country: 1996

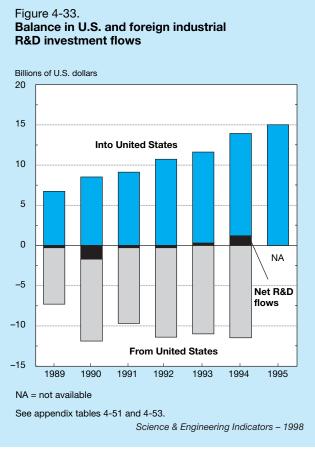
Industry	Total	Japan	United Kingdom	Germany	France	Switzer- land	South Korea	Nether- lands	Canada	Other
				· · · · · ·						
Total	676	244	102	93	44	42	32	30	20	69
Computers	39	22	1	2	0	0	7	2	5	0
Software	49	34	8	2	0	0	1	1	2	1
Semiconductors	32	18	0	2	0	0	10	2	0	0
Telecommunications	35	17	3	4	2	1	0	1	7	0
Opto-electronics	19	9	3	2	0	0	0	0	0	5
HDTV, other electronics	59	32	9	7	3	1	5	1	1	0
Drugs, biotechnology	111	26	15	24	6	19	2	5	0	14
Chemicals, rubber	110	23	18	27	14	7	1	6	4	10
Metals	23	8	5	2	0	1	0	2	2	3
Automotive	50	31	1	8	2	0	4	2	0	2
Machinery	27	5	6	3	4	2	0	0	1	6
Instrumentation, medical devices	52	6	20	6	3	6	0	3	2	6
Food, consumer goods	61	11	11	4	1	9	1	9	4	11

HDTV = high-definition television

NOTE: Sum of industry details may not add up to country totals because of cross-industry R&D at facilities.

SOURCE: D.H. Dalton and M.G. Serapio, Jr., *Globalizing Industrial Research and Development* (Washington, DC: U.S. Department of Commerce, Technology Administration, 1998).

^{*}An R&D facility typically operates under its own budget and is located in a free-standing structure outside of and separate from the parent's other U.S. facilities (e.g., sales and manufacturing). This definition of an R&D facility consequently excludes R&D departments or sections within U.S. affiliates of foreign-owned companies.



investments between Canada and the United States are in the \$1 billion to \$1.4 billion range. R&D flows remain small to negligible both into and out of Latin America and Africa.

U.S. Industry's Overseas R&D

Since 1985, U.S. firms generally increased their annual funding of R&D performed outside the country. (See appendix table 4-50.) Indeed, from 1985 to 1995, U.S. firms' investment in overseas R&D increased three times faster than did companyfunded R&D performed domestically (10.1 versus 3.4 percent average annual constant-dollar growth). Industries' total R&D performance, including funding from federal sources, grew at a meager 1.4 percent annual rate over the 1985-95 period. Equivalent to about 6 percent of industry's domestic R&D funding in 1985, overseas R&D now accounts for 12 percent of U.S. industry's on-shore R&D expenditures. 63 (See figure 4-35.) Additionally, according to BEA data, the majority-owned (that is, 50 percent or more) foreign-affiliate share of U.S. multinational companies' worldwide R&D expenditures increased from 9 percent in 1982 to 13 percent in 1990, where it remained through 1994 (Mataloni and Fahim-Nader 1996).

⁶³These overseas R&D shares are taken from the NSF industrial R&D data series, not the BEA Direct Investment Abroad series used in the "International R&D Investment Balance" discussion. However, BEA data on the country destination of the U.S. overseas R&D investment are more complete than the NSF series and therefore are used to describe country patterns. NSF reports 1994 and 1995 overseas R&D totals of \$9.4 billion and \$13.1 billion, respectively; BEA estimates 1994 overseas R&D expenditures by U.S. companies and their foreign affiliates at \$11.5 billion.

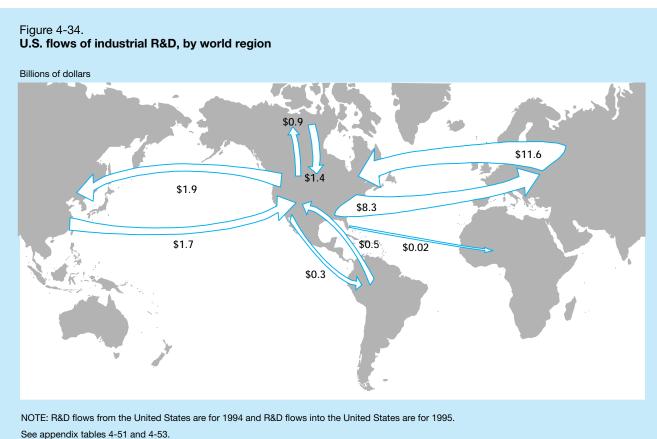
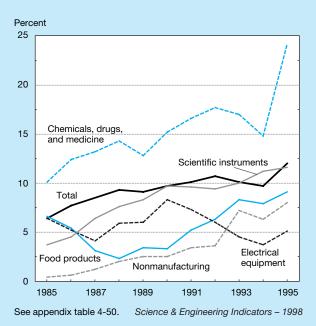


Figure 4-35.

Ratio of U.S. overseas R&D to company-financed domestic R&D, by industry



Lion's Share for Chemicals Industry. R&D investment by U.S. companies and their foreign subsidiaries in the chemicals (including pharmaceuticals and industrial chemicals) industry accounts for the largest share and greatest growth of foreign-based R&D activity. Indeed, drug companies accounted for 20 percent of total 1995 overseas R&D (\$2.6 billion of the \$13.1 billion total)—equivalent to 25 percent of the pharmaceutical industry's domestically financed R&D. (See appendix table 4-50.) Of other major R&D-performing manufacturers, recent trends show the overseas R&D investment share of total R&D financing rising considerably for scientific instruments and the food industry.

Increased R&D Activity in Nonmanufacturing Industries. Similarly, the combined total for all nonmanufacturing industries shows substantial increases in foreign R&D activity since 1985, rising from 0.4 percent of domestic R&D funding that year to 8.0 percent in 1995. Part of this growth reflects increased international R&D financing by firms historically classified as nonmanufacturing industries (particularly computer, data processing, and architectural services). Part of the increase reflects the movement of firms previously classified as manufacturers (e.g., office computing companies) to service sector industries (e.g., software development).

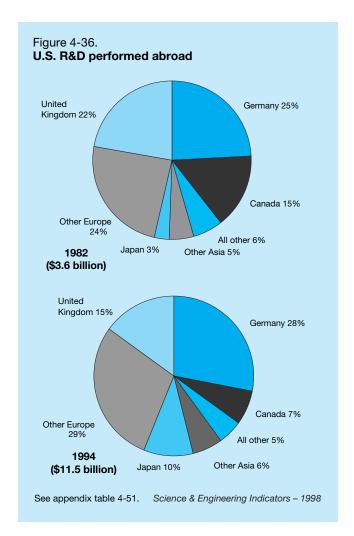
Most R&D Performed in Europe, Though Shifting East. As indicated by BEA data on majority-owned foreign affiliates of nonbank U.S. multinational companies, most of the U.S. 1994 overseas R&D was performed in Europe—primarily Germany (28 percent of the U.S. overseas total), the United Kingdom (15 percent), France (11 percent), and Ireland (4 percent). (See figure 4-36 and appendix table 4-51.) Collectively, however, the current 72 percent European share of the U.S.

total R&D investment abroad is somewhat less than the 78 percent share reported as recently as 1990. Since the early 1980s, U.S. R&D investments abroad have generally shifted away from the larger European countries and Canada, and toward Japan and other Asian countries.

By affiliate industry classification, more than one-half of the 1994 German-based R&D was performed by transportation equipment companies. In the United Kingdom and France, the chemicals industry accounted for the largest share of each countries' respective totals, whereas in Ireland, the machinery industry performed most of this U.S.-funded R&D. In Japan, which accounted for 10 percent of U.S. companies' 1994 R&D performed abroad, the largest share was performed in chemicals firms' foreign affiliates. (See text table 4-11.) Notably, the U.S. R&D investment in Asian countries other than Japan has grown substantially; for example, U.S. R&D spending in Singapore (primarily in machinery industries) now surpasses that in many European nations.

Foreign R&D in the United States

Like U.S. firms' overseas R&D funding trends, R&D activity by foreign-owned companies in the United States has increased significantly since the mid-1980s. From 1987 to 1995, inflation-adjusted R&D growth from foreign firms (U.S.



Text table 4-11. **R&D** performed overseas by majority-owned foreign affiliates of U.S. parent companies, by selected region/country and industry of affiliate: 1994

(Millions of dollars)

		Manufacturing								
Region/country	All industries	Total	Chemicals	Machinery	Electrical equipment	Transportation equipment	Nonmanu- facturing			
Total	12,097	10,147	3,119	2,034	797	2,812	1,950			
Canada	861	D	226	34	D	272	D			
Europe	8,791	D	2,204	1,600	D	2,309	D			
Belgium	516	373	344	3	2	4	143			
France	1,357	1,142	543	202	D	D	215			
Germany	2,808	2,630	296	530	128	1,435	178			
Ireland	462	435	87	292	43	0	27			
Italy	409	382	189	93	26	30	27			
Netherlands	418	345	63	12	163	5	73			
Switzerland	191	D	10	8	D	0	D			
United Kingdom	2,179	1,938	616	433	D	D	241			
Rest of Europe	451	D	56	27	D	D	D			
Asia and Pacific	1,856	1,381	D	381	D	68	475			
Australia	230	D	40	D	1	D	D			
Japan	1,123	787	397	77	136	6	336			
Singapore	238	225	2	195	27	0	13			
Taiwan	110	D	D	D	D	D	D			
Western Hemisphere	481	465	197	14	22	164	16			
Brazil	239	235	50	5	14	D	4			
Mexico	185	182	115	9	7	D	3			
Middle East	94	D	D	5	D	0	D			
Africa	15	14	10	1	*	*	1			

^{* =} less than \$500,000; D = withheld to avoid disclosing operations of individual companies

NOTES: Includes direct investments of majority-owned nonbank foreign affiliates of U.S. parents. Includes R&D expenditures conducted by the foreign affiliates for themselves or for others under a contract. Bureau of Economic Analysis expenditures differ from National Science Foundation-reported expenditures in appendix table 4-50.

SOURCE: U.S. Bureau of Economic Analysis, U.S Direct Investment Abroad: Operations of U.S. Parent Companies and Their Foreign Affiliates (Washington, DC: U.S. Government Printing Office, 1997).

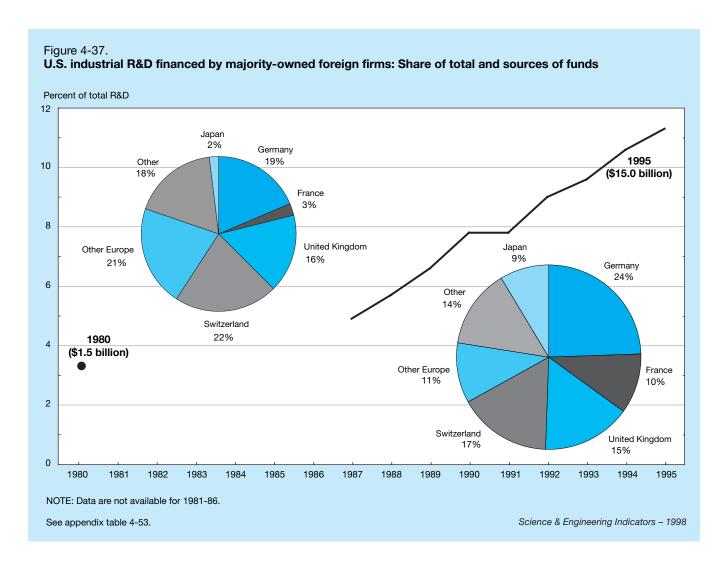
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affiliates with a foreign parent that owns 50 percent or more of the voting equity) averaged 12.5 percent per year.⁶⁴ This growth contrasts quite favorably with the implied 3 percent average annual rate of real increase in U.S. firms' domestic R&D funding, and is almost 10 times the 1.3 percent 1987-95 growth rate of total domestic industrial R&D performance (including activities funded by foreign firms and the Federal Government). As a result of these various funding trends, for-

eign R&D was equivalent to 11 percent (\$15 billion) of total industrial R&D performance in the United States in 1995—or more than double that of its equivalent 5 percent share in 1987. Majority-owned affiliates accounted for just a 3 percent share of the U.S. 1980 industrial performance total. (See figure 4-37.)

Most R&D Flows From Five Countries. The geographic pattern of R&D flows into the United States differs from the trends noted for U.S. R&D spending abroad. Whereas countries other than G-7 countries have become increasingly important as a destination for U.S. funding, they are less important in terms of foreign R&D investments here. In 1995, 75 percent of foreign funding came from just five countries—Germany, Switzerland, the United Kingdom, France, and Japan. In 1980, firms from these five countries accounted for 62 percent of foreign R&D flows into the United States. Although the R&D flows from Canada and other European countries also increased steadily over the past 15 years, at least part of the significant expansion of foreign R&D ex-

⁶⁴Although BEA considers all of an investment (including R&D) to be foreign if 10 percent or more of the investing U.S.-incorporated firm is foreign-owned, special tabulations were prepared by BEA to reveal R&D expenditures in the United States of those firms in which there is majority foreign ownership of 50 percent or more. For 1995, the 10 percent foreign ownership threshold results in an estimated \$17.7 billion foreign R&D investment total. (See appendix table 4-52.) R&D expenditures of majority-owned U.S. affiliates of foreign companies were \$15 billion. (See appendix table 4-53.) Tabulations for the majority-owned firms' R&D financing are used for most of the analyses provided here; the sole exception is the use of foreign R&D data at the 10 percent threshold for review of country-specific funding patterns for individual industrial sectors. (See text table 4-12.) Such data for majority-owned affiliates are not available.



penditures is attributable to several major acquisitions by foreign multinational companies of U.S. firms, particularly of U.S. pharmaceutical and biotechnology firms with large R&D budgets.

Research Concentrated in Three Industries. Foreign-funded research was concentrated in three industries in 1995—drugs and medicines (mostly from Swiss and British firms), industrial chemicals (funded predominantly by German firms), and electrical equipment (one-third of which came from French affiliates). These three industries accounted for three-fifths of the \$17.7 billion total 1995 foreign R&D investment by affiliates in which there was at least 10 percent foreign ownership. Concurrent with gains reported for all domestic U.S. R&D performance, foreign—particularly Japanese—R&D investment in the service sector was also significant. These industries accounted for 5 percent (\$900 million) of the 1995 foreign R&D investment total, with most research being funded in computer, data processing, and research and management services. (See text table 4-12.)

Summary

There was a resurgence in R&D investment in the United States in the mid-1990s. A prosperous economy has invigorated companies in both the manufacturing and service sectors, enabling them to allocate more resources toward the discovery of new knowledge and the application of that knowledge in the development of new products, processes, and services. An upsurge in innovation is further contributing to a buoyant economy.

At the same time that the private sector's role in maintaining the health of U.S. R&D enterprise has been expanding, the Federal Government's contribution has been receding, as the federal share has become less prominent in both the funding and the performance of R&D. As a result of these two divergent funding trends, the composition of the nation's R&D investment is slowly shifting. For example, recently, a growing percentage of the nation's R&D total has been directed toward nondefense activities. While industry has focused its R&D on new product development, the Federal Government historically has been the primary funding source for basic research activities.

⁶⁵ Totals are for R&D expenditures for U.S. affiliates of firms in which there is 10 percent or more foreign ownership. (See previous footnote.)

Text table 4-12. **R&D** performed in the United States by affiliates of foreign companies, by selected region/country and industry of affiliate: 1995
(Millions of dollars)

			Manufacturing							
Region/country	All industries	Total	Drugs & medicines	Other chemicals	Machinery	Electrical equipment	Transpor- tation equipment	Instru- ments	Service industries ^a	Other industries ^b
Total	17,666	14,743	5,255	3,071	1,089	2,770	478	682	922	2,001
Canada	1,396	1,320	*	24	13	D	D	D	18	58
Europe	13,370	11,926	5,167	2,962	584	1,482	316	506	557	887
France	1,844	1,594	5	79——	127	424	52	106	35	215
Germany	3,976	3,676	759	2,026	5	83	144	45	38	262
Netherlands	838	609	1	303	*	D	7	D	35	194
Switzerland	3,088	2,688	2,268	47	89	110	*	D	351	49
United Kingdom	2,419	2,178	1,4	20——	94	103	83	206	80	161
Asia and Pacific	2,435	1,228	77	78	467	D	D	48	339	868
Japan	1,867	1,052	70	60	389	192	39	38	323	492
Western Hemispher	e 280	148	0	*	3	3	1	D	3	129
Middle East	98	D	11	0	10	D	0	6	5	D
Africa	68	D	0	0	2	0	0	0	*	D

^{* =} less than \$500,000; D = withheld to avoid disclosing operations of individual companies

NOTES: Not all countries and industries are shown. Includes foreign direct investments of nonbank U.S. affiliates only. Includes R&D expenditures conducted by and for the foreign affiliates. Excludes expenditures for R&D conducted for others under a contract. Expenditures differ from Bureau of Economic Analysis-reported expenditures in appendix table 4-53.

alncludes computer and data processing services (\$402 million) and accounting, research, and management services (\$456 million).

blncludes wholesale trade (\$1,412 million) and petroleum (\$387 million).

SOURCE: U.S. Bureau of Economic Analysis, Foreign Direct Investment in the United States: Operations of U.S. Affiliates of Foreign Companies Preliminary 1995 Estimates (Washington, DC: U.S. Government Printing Office, 1997).

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Although more positive than negative indicators of the health of R&D funding have appeared in recent years, there is some cause for concern that short-term R&D may be displacing the longer term quest for new knowledge and breakthrough discoveries. To compensate for what may be a recession in long-term fundamental research, new trends have been emerging. Greater reliance is being placed on the academic research community, and all sectors have expanded their participation in a variety of domestic and international partnerships both within and across sectors. The rapid rise in global R&D investments is evident from the expansion of industry's overseas R&D spending and the even more rapid rise in foreign firms' R&D spending in the United States. These domestic and foreign collaborations permit performers to pool and leverage resources, reduce costs, and share the risks associated with research activities. In addition, such alliances and international investments open a host of new scientific opportunities for R&D performers, enabling them to accelerate the exploration and deployment of promising new research and technologies that undoubtedly will be the source of tomorrow's new products and services.

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Chapter 5

Academic Research and Development: Financial and Personnel Resources, Integration With Graduate Education, and Outputs

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Highlights

FINANCIAL RESOURCES FOR ACADEMIC R&D

- ♦ In 1997, an estimated \$23.8 billion (in current dollars) was spent for research and development (R&D) at U.S. academic institutions (\$21.1 billion in constant 1992 dollars). The Federal Government provided \$14.2 billion; academic institutions, \$4.4 billion; state and local governments, \$1.8 billion; and industry and other sources each provided \$1.7 billion.
- ♦ Industrially performed R&D grew faster than academic R&D between 1994 and 1997, and the academic sector's share fell to 12 percent, reversing a decade-long trend of an increasing role for academic performers in total U.S. R&D. Between 1984 and 1994, academia had risen from a 9 percent share to a 13 percent share of total U.S. R&D performance.
- ♦ The academic sector performs over 50 percent of basic research, continuing to be the largest performer of basic research in the United States. Academic R&D activities are concentrated at the basic research end of the R&D spectrum. Of estimated 1997 academic R&D expenditures, an estimated 67 percent went for basic research, 25 percent for applied research, and 8 percent for development.
- ♦ The Federal Government continues to provide the majority of funds for academic R&D. It provided an estimated 60 percent of the funding for R&D performed in academic institutions in 1997, down from about 65 percent in the early 1980s. Although nonfederal support increased more rapidly than federal through most of the 1980s, this trend was reversed in the first half of the 1990s. Federal support has grown more slowly than nonfederal in both 1996 and 1997, however.
- ♦ Federal obligations for academic R&D are concentrated in three agencies: the National Institutes of Health (NIH—57 percent), the National Science Foundation (NSF—15 percent), and the Department of Defense (DOD—10 percent). The National Aeronautics and Space Administration (6 percent), the Department of Energy (5 percent), and the Department of Agriculture (3 percent) provide an additional 14 percent of obligations for academic R&D. Federal agencies emphasize different science and engineering (S&E) fields in their funding of academic research. Several agencies concentrate their funding in one field; others have more diversified funding patterns.
- ♦ There has been a significant increase in the number of universities and colleges receiving federal R&D support during the past two decades, with almost the entire increase occurring among other than research and doctorate-granting institutions. In 1995, 654 of these institutions received R&D support from the Federal Government, compared to 422 in 1985 and 335 in 1975.

- ♦ After the Federal Government, the academic institutions performing the R&D provided the second largest share of academic R&D support. The institutional share grew from about 14 percent of academic R&D expenditures in the early 1980s to an estimated 19 percent in 1997. Some of these funds directed by the institutions to research activities derive from federal and state and local government sources, but—since they are not restricted to research and the universities decide how to use them—they are classified as institutional funds.
- ♦ Industrial R&D support to academic institutions has grown more rapidly than support from all other sources in recent years. In constant dollars, industry-financed academic R&D increased by an estimated average annual rate of 8.1 percent between 1980 and 1997. Industry's share grew from 4 percent to an estimated 7 percent during this period.
- ♦ Total academic S&E research space increased by almost 22 percent between 1988 and 1996, up from about 112 million to 136 million net assignable square feet. When completed, construction projects initiated between 1986 and 1995 are expected to produce 52 million square feet of new research space, equivalent to about 39 percent of existing space.
- ♦ In 1996, 55 percent of research-performing institutions reported construction or repair/renovation projects that were needed but had to be deferred because funds were not available. The cost of these deferred projects was \$9.3 billion. Sixty percent of the needs reported were for construction and 40 percent were for repair/renovation.
- ♦ Expenditures for academic research instrumentation in U.S. research universities began increasing recently. This increase follows a pattern of large increases in investment throughout most of the 1980s, followed by a steady decline of about 2 percent a year between 1989 and 1993. Annual research equipment expenditures as a percentage of total R&D expenditures declined from 7.2 percent in 1986 to 5.2 percent in 1993 before rising again to 5.6 percent in 1995.
- ♦ Computers and data handling equipment represented 19 percent of the number of instruments in the national stock and 30 percent of total aggregate cost. There were an estimated 61,684 instruments with an estimated aggregate original purchase price of \$6.255 billion in the stock of research instruments at the 318 colleges, universities, and medical schools represented in the National Survey of Academic Research Instruments and Instrumentation Needs in 1993.

THE ACADEMIC DOCTORAL S&E WORKFORCE

- ♦ The 217,500 academic doctoral scientists and engineers in 1995 represented the largest number ever employed in the academic sector. But employment growth for this highly trained group was stronger in other parts of the economy, and the academic sector's employment share stood at 46 percent—a record low.
- ♦ Full-time doctoral S&E faculty numbered an estimated 171,400 in 1995, a decline from 173,100 in 1991. Full-time faculty represented 79 percent of academic doctoral S&E employment in 1995, down from 88 percent in 1973. Much of the decline occurred among those with the rank of full professor.
- ◆ The number of women with S&E doctorates who held academic positions increased to 52,400 in 1995. This represented a new high to 24 percent of total academic employment of doctoral scientists and engineers. Women remained highly concentrated in the life and social sciences and psychology.
- ♦ Minority employment continued to grow and reached 35,300 in 1995, but stayed at low levels for some groups. The 12,800 members of underrepresented groups—black, Hispanic, Native American, and Alaskan Native—accounted for 6 percent of academic doctoral scientists and engineers, up from 2 percent in 1973. Asian employment in 1995 stood at 22,500, or 10 percent of the total; this was up from 4 percent in 1973.
- ♦ Women and members of minority groups have tended to enter academic employment in line with or above their proportion of recently awarded S&E doctorates. Among recent Ph.D. recipients in academic employment—doctorates awarded in the preceding three years—women and underrepresented minorities were employed in rough proportion to their share of newly awarded doctorates to U.S. citizens and permanent visa-holders; Asians—many of whom are foreign-born—were represented well in excess of their share of new S&E Ph.D.s.
- ♦ The progressive aging of the doctoral academic S&E workforce, evident over much of the past two decades, appears to have leveled off. The mean age of full-time doctoral faculty rose from 42.5 years in 1973 to 47.1 years in 1989 and stood at 47.4 years in 1995, suggesting gradual hiring for the system as a whole as faculty retire. However, for young Ph.D.s, this has to be seen in the context of a steep increase in newly awarded doctorates—from about 22,700 in 1989 to 27,800 in 1995.

- ♦ An estimated 26,900 recent Ph.D. recipients—doctorates awarded in 1992-94—entered academic employment in 1995. But the meaning of academic "employment" has changed for these young doctorate-holders. Fewer than 45 percent had regular faculty appointments, compared with over 75 percent in the early 1970s, while the proportion in postdoctorate positions rose from 13 to 40 percent.
- ◆ The physical sciences have grown more slowly than other fields in terms of overall doctoral employment— 29,300 in 1995—and doctorates in full-time faculty positions. Their doctoral employment share fell from 19 percent in 1973 to 13 percent in 1995. The life sciences, engineering, and psychology gained employment shares.

WORK RESPONSIBILITIES OF ACADEMIC DOCTORAL SCIENTISTS AND ENGINEERS

- ◆ The academic doctoral S&E research workforce—defined as those whose primary or secondary work responsibility was research—numbered an estimated 153,500 in 1995, up from 80,000 to 90,000 during the 1970s. The highest levels of research participation, so defined, were found in engineering and the environmental sciences; the lowest in mathematics, psychology, and the social sciences.
- ♦ In 1995, 39 percent of the academic doctoral workforce—85,700—reported having research support from the Federal Government during the week of April 15. This compares with 37 percent in 1993. A sizable fraction of those with federal funding—26 percent—obtained their support from more than one agency.
- ♦ The number of those reporting teaching as their primary activity has fluctuated around the 100,000 mark since 1985. In contrast, those designating research as primary rose from 56,000 to 83,000 over the period. In 1995, 46 percent of respondents reported teaching as their primary work responsibility, compared with 38 percent who reported research.
- ◆ Doctoral S&E employment growth in Carnegie research universities was largely confined to those identifying research as their primary activity—from 17,500 in 1973 to 45,900 in 1995. In other types of institutions, the number choosing research grew from 10,300 to 37,100 over the period.

INTEGRATION OF RESEARCH WITH GRADUATE EDUCATION

- ♦ In 1995, for the first time in almost two decades, enrollment of full-time S&E graduate students declined slightly. The enrollment decline was irrespective of primary source of support. The numbers of full-time graduate students with primary support from the Federal Government, nonfederal sources, or their own resources (self-support) all declined.
- ♦ The proportion of full-time graduate students in S&E with a research assistantship as their primary mechanism of support has increased considerably. Research assistantships were the primary support mechanism for 66 percent of the students whose primary source of support was from the Federal Government in 1995, compared to 55 percent in 1980. For students whose primary source was nonfederal, research assistantships rose from 20 percent to 29 percent of the total during this period. The overall number of graduate students with a research assistantship as their primary mechanism of support increased every year between 1985 and 1994 before declining slightly in 1995.
- ♦ The Federal Government plays a larger role as the primary source of support for some support mechanisms than for others. A majority of traineeships in both private and public institutions (53 and 73 percent, respectively) are financed primarily by the Federal Government, as are 60 percent of the research assistantships in private and 47 percent in public institutions.
- ♦ NIH and NSF have been the primary source of federal support for full-time S&E graduate students relying on research assistantships as their primary support mechanism. From the early 1970s to the late 1980s, NSF was the federal agency that was the primary source for graduate research assistantships. It was surpassed by NIH in 1993. Between 1972 and 1995, the proportion of federal graduate research assistantships financed primarily by NSF declined from one-third to less than one-quarter, while the proportion financed primarily by NIH increased from one-sixth to one-quarter.
- ◆ Research assistantships are more frequently identified as a primary mechanism of support in the physical sciences, the environmental sciences, and engineering than in other disciplines. Research assistantships comprise more than 50 percent of the primary support mechanisms for graduate students in astronomy, atmospheric sciences, oceanography, agricultural sciences, chemical engineering, and materials engineering. They account for less than 20 percent in the social sciences, mathematics, and psychology.

ARTICLE OUTPUTS FROM SCIENTIFIC AND ENGINEERING RESEARCH

- ♦ In 1995, about 142,800 scientific and technical articles were published by U.S. authors in a set of journals included in the Science Citation Index (SCI) since 1981. The bulk—71 percent—were by academic authors. Eight percent each had authors affiliated with other major sectors: industry, government, and nonprofit organizations.
- ♦ Publications by U.S. industrial authors rose strongly in life science fields—clinical medicine, biomedical research, and biology—and constituted nearly half of industry publications; this was up from 19 percent in 1991. From the late 1980s on, industry output in engineering and technology was lower than it had been in preceding years.
- ♦ Increasingly, scientific collaboration in the United States involves scientists and engineers from different employment sectors. In 1995, just under one-quarter of all academic papers involved such cross-sectoral collaboration—6 percent with industry, 8 percent each with the federal and not-for-profit sectors, 3 percent with federally financed research and development centers, and 2 percent with other sectors. In the other sectors, well over half of their cross-sector collaborations involved academic authors.
- ◆ Globally, five nations produced more than 60 percent of the 439,000 articles in the SCI set of journals in 1995: the United States (33 percent), Japan (9 percent), the United Kingdom (8 percent), Germany (7 percent), and France (5 percent). No other country's output reached 5 percent of total.
- ◆ The development or strengthening of national scientific capabilities in several world regions was evident in faster publications output growth elsewhere than in the United States; growth elsewhere accelerated toward the mid-1990s, overshadowing continued growth in U.S. output. This continued a long-term decline in the U.S. share of total article output.
- ◆ Europe accrued gains in output share—from 32 percent in 1981 to 35 percent in 1995. Asia's share rose from 11 to 15 percent, even though India's output declined by onethird in absolute number of articles over the period.
- ♦ The number of articles in physics, earth and space sciences, and biomedical research increased the most rapidly—by 63, 36, and 30 percent, respectively—from 1981 to 1995. The output volume of articles in chemistry, clinical medicine, and engineering and technology was little changed; those for mathematics and biology declined.

- ♦ Great variation marked countries' article outputs per billion U.S. dollars of their estimated 1995 gross domestic product. Israel and some smaller European nations ranked highest, exceeding 30 articles per billion. The United States was in the middle range, with 20 articles. Nations with fast-developing economies had smaller than expected article outputs, reflecting the recent rapidity of their economic strides and suggesting considerable room for further scientific growth.
- ♦ Countries' science portfolios, as reflected in their published output, show some striking differences. Clinical medicine and biomedical research are heavily emphasized in the article outputs of the United States, United Kingdom, the countries of Northern Europe, several smaller Western European nations, and Chile. Chemistry and physics form a larger than average fraction of the output of France, Germany, Spain, Italy, Eastern Europe, Russia, Mexico, and many Asian countries. Russia, China, Egypt, and Asian countries emphasize engineering and technology.

INTERNATIONAL COLLABORATION AND CITATION OF RESEARCH OUTPUTS

- ♦ The globalization of science is reflected in a pervasive trend in scientific publishing toward greater collaboration. In 1995, half of the articles in the SCI journals had multiple authors, and almost 30 percent of these involved international collaboration. This trend affected all fields, and a steadily growing fraction of most nations' papers involved coauthors from different nations. By 1995, article outputs since 1981 had grown by 20 percent, the number of coauthored articles by 80 percent, and the number with international coauthors by 200 percent.
- ♦ For almost every nation with strong international coauthorship ties, the *number* of articles involving a U.S. author rose strongly between 1981 and 1995. Concur-

- rently, however, many nations broadened the reach of their international collaborations, causing a diminution of the U.S. *share* of the world's internationally coauthored articles.
- ♦ Citation patterns also mirror the global nature of the scientific enterprise, as researchers everywhere extensively cite research outputs from around the world. U.S. scientific and technical articles as a whole are cited by virtually all mature scientific nations in excess of the U.S. output's world share. This holds for chemistry, physics, biomedical research, and clinical medicine. U.S. articles in other fields tend to be cited at or slightly below their world output share.
- ♦ The number of article citations on U.S. patents increased from 8,600 in 1987 to 47,000 in 1996, and their field distribution shifted strongly toward the life sciences. This rise in number of citations held for all fields and for papers from all sectors, with the fastest growth in citations to biomedical research and clinical medicine.
- ♦ The number of academic patents, while small, rose more than sevenfold in just over two decades—from about 250 annually in the early 1970s to more than 1,800 in 1995—and the number of academic institutions receiving patents increased from about 73 in the early 1980s to 168 by the mid-1990s. Academic patenting increased more rapidly than all annual U.S. patent awards. Among institutions with patents are a growing number of universities and colleges not traditionally counted among the research universities.
- ♦ Academic patents are concentrated in fewer utility classes than patents overall; in fact, patents in only three utility classes with presumed biomedical applicability constituted more than a quarter of all academic patents in 1995. Revenue from academic patenting reached \$299 million in 1995.

Introduction

Chapter Background

The academic research and development (R&D) enterprise has enjoyed strong growth for the past decade but is facing some issues arising partly from its own success, partly from changes in its environment.

The nation's universities and colleges continue to perform more than half of U.S. basic research. Though faced with severe financial pressures, their own R&D funds are nearing one-fifth of their total R&D expenditures. At the same time, industry relies increasingly on academic R&D. There is more collaboration between industrial and academic researchers, and patent citing to academic publications is increasing. Industry support has grown, but remains well below 10 percent of the total funding of research in academia; furthermore, industry funding cannot be expected to become a mainstay of academic research funding.

The Federal Government continues to provide the majority of academic R&D support. Three agencies provide the bulk of these funds—the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Department of Defense (DOD). NSF and DOD together provide much of the nation's R&D support for the physical and computer sciences, mathematics, and engineering.

Demographic projections point to the potential for strong enrollment growth over the next decade and the continuation of several trends: more minority participation, more older students, more nontraditional students. Foreign graduate students, however, may attend U.S. institutions in lesser numbers. ¹ In this context, and driven by financial and other pressures, universities and colleges will continue to debate questions about their focus and mission. These discussions will take place against the backdrop of faculty retirements. An unresolved question is the extent and nature of replacement hiring into tenure-track faculty positions versus other, more temporary, appointments.

Urgent questions about the nature of graduate education are being raised. Is the current model the appropriate one, or should training allow for broader and more varied application of skills in the marketplace? Should students be given more autonomy from their professors, perhaps by way of restructuring their modes of support? What is the appropriate role for the Federal Government in this support? Continued increases in the number of foreign students, vital for many graduate programs, cannot be taken for granted. Thus, issues about the nature of graduate education join with questions of university missions and program organization.

The research universities are valued as a national resource. They educate and train large proportions of the nation's scientists and engineers, embody the model of integrated graduate training and research, and conduct much of the nation's basic research. Yet they face difficult questions. Is the nature

of their graduate training up to the task of developing a highquality yet flexible workforce of scientists and engineers? Is it driven too much by research? Is their research enterprise too insular, too driven by its own dynamic or external demands from the Federal Government or industry? Does it cost too much? How can research be better connected to undergraduate education? Other universities increasingly face these same questions, as the growth of the research function continues in institutional segments that have not traditionally been considered among the research universities.

Answers to these and other questions will emerge gradually, as individual institutions respond to the challenges and opportunities they perceive. The nation's universities and colleges have shown great ability to adapt to changed realities. In time, it will become possible to take stock of the changes and assess their extent. Many issues underlying these changes will persist, as higher education institutions try to find the appropriate balance among their many functions. (See "Developments Impinging on Academia.")

This chapter addresses several key aspects of the academic R&D enterprise including financial resources, physical infrastructure, science and engineering (S&E) doctoral employment, the integration of research and graduate education, and research outputs. The questions raised in the preceding discussion are difficult ones to resolve and relate to highly complex issues. This chapter, while not providing definitive answers to these questions, does provide data trends and analysis to assist decisionmakers in assessing these issues.

Chapter Organization

The chapter opens with a discussion of trends in the financial resources provided for academic R&D, including allocations across both academic institutions and S&E fields. Since the Federal Government has been the primary source of support for academic R&D for over half a century, the importance of selected agencies in supporting individual fields is explored in some detail. Data are also presented on changes in the number of academic institutions receiving federal R&D support. The section next examines the status of two key elements of university research activities—facilities and instrumentation. Topics explored include their funding, adequacy, and unmet needs.

The next section discusses trends in the employment, demographic characteristics, and activities of academic doctoral scientists and engineers. The discussion of employment trends focuses on full-time faculty and other positions. Trends in the involvement of women, underrepresented minorities, and Asians are explored, as are shifts in the faculty age structure. Special attention is given to participation in research by academic doctoral scientists and engineers and the federal support reported for these activities. Selected demographic characteristics of recent doctorate-holders entering academic employment are examined.

The third section looks at the relationships between research and graduate education. It covers overall trends in graduate support and patterns of support in different types of

¹For a discussion of this point, see chapter 2, "Foreign Doctoral Students in the United States."

Developments Impinging on Academia

The nation's universities and colleges are facing changes in finances, enrollment, faculty, and environment whose eventual results cannot be foreseen with any degree of confidence. Cost pressures seem unabated; state funding to public institutions may benefit from a strong economy but faces competition from other uses. Overall enrollment in the nation's four-year colleges and universities declined somewhat in the early 1990s after rising during the preceding decade. However, the U.S. Department of Education projects rising numbers of students at U.S. universities and colleges over the coming decade or more, based on demographic projections and assumptions about cohort participation rates in higher education. The available evidence suggests that the racial/ethnic makeup of the student body will continue to change, and that women will continue to make inroads into fields that they have not traditionally entered. The number of foreign students, long a mainstay for many graduate programs in science and engineering, may decline as other countries develop their own programs. Faculty retirements are expected to rise, based on the age structure; but institutions' responses to this situation are not clear. Replacement hiring may take place, or some portion of the teaching burden may be shifted to temporary or nonfaculty employees. Media-based teaching and learning developments might affect the roles of teachers and of higher education institutions—and might perhaps even affect enrollments. State governments are looking at universities as regional economic development engines and sources of innovation, and the institutions themselves pay increasing attention to these types of activities.

Current discussions about university roles, structures, and priorities will need to take account of these and other factors. It is difficult to predict with any degree of precision the course of any one of these factors, much less their combined impacts on the future shape of the U.S. higher education enterprise as set in an increasingly skill-based society.

institutions, and compares support patterns for those who complete an S&E doctorate with the full population of graduate students. The extent of participation by graduate research assistants in academic research is examined, as are the sources of support for research assistants and the spreading incidence of research assistantship (RA) support to a growing number of academic institutions.

The chapter's final section deals with two research outputs: scientific and technical articles in a set of journals covered by the Science Citation Index (SCI), and patents issued

to U.S. universities. (A third major output of academic R&D, educated and trained personnel, is discussed in the preceding section of this chapter and in chapter 2.) The section specifically looks at the output volume of research (article counts), collaboration in the conduct of research (joint authorships), use in subsequent scientific activity (citation patterns), and use beyond science (citations to the literature on patent applications).

Financial Resources for Academic R&D²

Adequate financial support for R&D activities at U.S. universities and colleges, as well as excellent research facilities and high-quality research equipment, is essential in enabling U.S. academic researchers to carry out world-class research. Since academic R&D is a significant part of the national R&D enterprise, this section focuses both on the levels and sources of support for R&D activities at U.S. universities and colleges as well as academic R&D facilities and instrumentation.

Overview³

In 1997, an estimated \$23.8 billion was spent on R&D at U.S. academic institutions. Academia's role as an R&D performer increased steadily between 1984, when this sector accounted—as it had for more than a decade—for just 9 percent of all R&D performed in the country, and 1994, when it performed almost 13 percent of all U.S. R&D. (See figure 5-1.) By 1997, the sector's performance share had dipped to just below an estimated 12 percent.

Character of Work

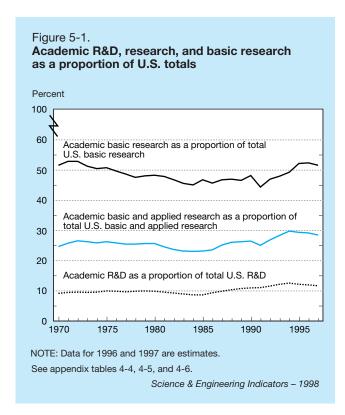
Academic R&D activities are concentrated at the research (basic and applied) end of the R&D spectrum and do not in-

²Data in this section come from several different National Science Foundation surveys; these do not always use comparable definitions or methodologies. NSF's three main surveys involving academic R&D are (1) the Federal Funds for Research and Development Survey; (2) the Federal Support to Universities, Colleges, and Selected Nonprofit Institutions Survey; and (3) the Scientific and Engineering Expenditures at Universities and Colleges Survey. The results from this last are based on data obtained directly from universities and colleges; the former two surveys collect data from federal agencies. For descriptions of the methodologies of these and other NSF surveys, see NSF (1995b and 1995c). Federally funded research and development centers associated with universities are tallied separately and are examined in greater detail in chapter 4.

³This discussion is based on data in NSF (1996b) and unpublished tabulations. For more information on national R&D expenditures, see chapter 4, "National R&D Spending Patterns."

⁴Academic institutions generally comprise institutions of higher education that grant doctorates in science or engineering and/or spend at least \$50,000 for separately budgeted R&D.

⁵Notwithstanding this delineation, the term "R&D"—rather than just "research"—is used throughout this discussion unless otherwise indicated, since almost all of the data collected on academic R&D do not differentiate between "R" and "D." Moreover, it is often difficult to make clear distinctions among basic research, applied research, and development. For the definitions used in NSF resource surveys, see chapter 4.



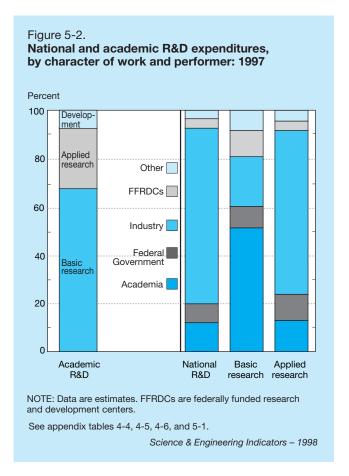
clude much development activity.⁵ Of 1997 academic R&D expenditures, an estimated 67 percent went for basic research, 25 percent for applied research, and 8 percent for development. (See figure 5-2.) From a national research—as opposed to national R&D—perspective, academic institutions accounted for between 23 and 30 percent of the U.S. total during the past three decades. In terms of $basic\ research\$ alone, the academic sector is the country's largest performer, accounting for between 44 and 53 percent of the national total during the past three decades. (See figure 5-1.)

Growth

Average annual R&D growth between 1984 and 1994 (in constant 1992 dollars) was much stronger for the academic sector than for any other R&D-performing sector—5.7 percent, compared to about 4.2 percent for other nonprofit laboratories, 1.5 percent for industrial laboratories, 0.6 percent for federally funded research and development centers (FFRDCs), and zero growth for federal laboratories. Since 1994, this growth has slowed to an estimated 1.6 percent annually; however, this rate is still higher than for any other R&D-performing sector but industry (which grew at an estimated 6.2 percent annually). As a proportion of gross domestic product (GDP), academic R&D rose from 0.23 to 0.30 percent between 1984 and 1997.

Funding Sources

The Federal Government continues to provide the majority of funds for academic R&D. In 1997, it accounted for an estimated 60 percent of the funding for R&D performed in

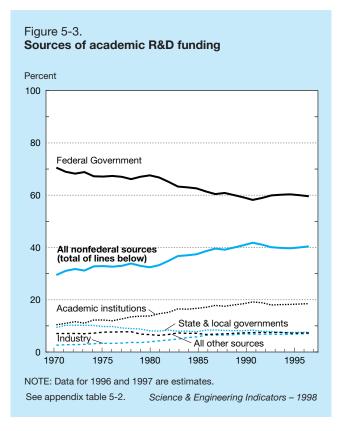


academic institutions. Nevertheless, the federal support share is declining fairly steadily, down from 68 percent in 1980 and 71 percent in 1970. (See figure 5-3.) Until the beginning of the 1990s, support from other sectors grew more rapidly than did that from the Federal Government. This trend reversed in the early 1990s, with federal support growing faster than nonfederal through 1995. Federal support is estimated to grow more slowly than nonfederal in both 1996 and 1997. The federal sector primarily supports basic research—71 percent of its 1997 funding went to basic research versus 20 percent to applied. Nonfederal sources provide a larger share of their support for applied research (61 percent for basic and 32 percent for applied research).

Federal support of academic R&D is discussed in detail later in this section; the following summarizes the contributions of other sectors to academic R&D.⁶

◆ Institutional funds. Institutional funds are separately budgeted funds that an academic institution spends on R&D from unrestricted sources, unreimbursed indirect costs associated with externally funded R&D projects, and mandatory and voluntary cost sharing on federal and other

⁶The academic R&D funding reported here only includes separately budgeted R&D and institutions' estimates of unreimbursed indirect costs associated with externally funded R&D projects, including mandatory and voluntary cost sharing. It does not include departmental research, and thus will exclude funds—notably for faculty salaries—in cases where research activities are not separately budgeted.



grants. These constitute the second largest source of academic R&D funding. The share of support represented by institutional funds has been increasing fairly steadily since 1980, save for a brief downturn in 1992 and 1993. In 1980, institutional funds accounted for about 14 percent of all academic R&D expenditures; the estimated 1997 share is about 19 percent. The major sources of institutional R&D funds are (1) general-purpose state or local government appropriations, particularly for public institutions; (2) general-purpose grants from industry, foundations, or other outside sources; (3) tuition and fees; (4) endowment income; and (5) gifts that are not restricted by the donor to research. Other potential sources of institutional funds are income from patents or licenses and income from patient care revenues. (See "Income From Patenting and Licensing Arrangements" later in this chapter; also see "Academic Research and the Changing U.S. Health Care System" for a discussion of how the level and nature of research at medical schools may be affected by changes in the U.S. health care system.)

♦ State and local government funds. The share of academic

R&D funding provided by state and local governments fluctuated slightly around the 8 percent level between 1980 and 1991, and declined steadily to just above 7 percent in 1994 before beginning a (slight) increase back up toward an estimated 8 percent in 1997. This share, however, only reflects funds directly targeted to academic R&D activities and does not include general-purpose state or local government appropriations that are used for separately budgeted research or to cover unreimbursed indirect costs. Consequently, the actual contribution of state and local governments to academic R&D is understated, particularly for public institutions.

- ♦ Industry funds. The funds provided for academic R&D by the industrial sector, although they account for the smallest share of funding, grew faster than did funding from any other source during the past two decades. Industry increased its share from slightly below 3 percent in 1970, to about 4 percent in 1980 and about 7 percent in 1990, where it has since remained. Industry's contribution to academia represented an estimated 1.3 percent of all industry-funded R&D in 1997, compared to 0.8 percent in 1980 and 0.6 percent in 1970. In the past two years, however, this relative contribution has declined slightly from its peak of 1.5 percent in 1994. "Industry-University Ties and the Conduct and Dissemination of Academic Research" touches on some of the concerns raised by industry funding of academic R&D, particularly its impact on the nature of university research and the dissemination of research findings.
- ♦ Other sources of funds. Other sources of support include grants for R&D from nonprofit organizations and voluntary health agencies and gifts from private individuals that are restricted by the donor to research, as well as all other sources restricted to research purposes not included in the other categories. Since 1986, this source of academic R&D support has stayed fairly constant at about 7 percent.

Funding by Institution Type

Patterns of sectoral funding of academic R&D vary depending on the type of academic institution involved. That is, the importance of different funding sources varies for both private and public universities. (See appendix table 5-3.) For all public academic institutions combined, just under 10 percent of R&D funding in 1995—the most recent year for which data are available—came from state and local funds, about 23 percent from institutional funds, and about 54 percent from the Federal Government. Private academic institutions received about 2 percent of funds from state and local governments, 9 percent from institutional sources, and 73 percent from the Federal Government. Both public and private institutions received approximately 7 percent of their respective R&D support from industry in 1995. Over the past two decades, the federal share of support has declined, and the industry and institutional shares have increased, for both public and private institutions.

⁷Some of the growth in institutional R&D funds may be due to accounting changes, including both a shift of departmental research to separately budgeted research and increased institutional ability to calculate unreimbursed indirect costs, including mandatory and voluntary cost sharing. Available data suggest, however, that it is unlikely that this accounts for the bulk of the increase. Growth in institutional R&D funds has been roughly in line with growth in academic institutions' total operating expenditures over the past two decades. Growth has also been steady over the entire time period, without the sudden shifts that would be expected if better or significantly different reporting were to occur simultaneously in a large number of institutions.

Academic Research and the Changing U.S. Health Care System

Clinical revenues generated by medical school faculty have traditionally been used to support undergraduate and graduate medical education and research at U.S. medical schools. These revenues are also thought to be a major source of support for younger researchers, who often have difficulty obtaining external grants. In a study for the American Association of Medical Colleges Task Force on Medical School Financing (Jones and Sanderson 1996), it is estimated that clinical revenues generated by medical school faculty to support core academic programs totaled \$2.4 billion in 1993. The major beneficiary of this support (\$816 million) was found to be research, followed by undergraduate medical education (\$702 million) and graduate medical education (\$594 million). Jones and Sanderson note that hospitals may also provide clinical support for academic missions by applying hospital funds to academic programs and by absorbing academic program expenses that are not otherwise reimbursed. However, changes in the U.S. health care system—particularly the emergence of managed care, the growing consolidation of health care providers, and increased price competition—are believed to be adversely affecting both the level and nature of research at medical schools. For example, two recent studies (Moy et al. 1997; and Campbell, Weissman, and Blumenthal 1997) suggest that faculty members at U.S. medical schools might be conducting less clinical research because of pressure on their institutions to cut costs and raise revenues. They show that in regions where managed care plans are dominant and where there is stiff competition for dollars and patients among hospitals, physicians

at academic medical centers report more pressure to take care of patients—and thus conduct fewer human studies, do less clinical research, and publish fewer papers.

The main finding of the Moy study is that medical schools in all markets had comparable rates of growth in NIH awards from 1986 to 1990, but that between 1990 and 1995, medical schools in markets with high managed care penetration had slower growth in the dollar amount and number of awards compared with schools in markets with medium or low managed care penetration. The authors conclude that their results "provide evidence of an inverse relationship between growth in NIH awards during the last decade and managed care penetration among U.S. medical schools," although they do state that it remains to be determined whether the association is causal. One of the findings of the Campbell study is that clinical researchers in less competitive health care markets published more scientific articles than those in more competitive health care markets. Another finding is that a significantly larger proportion of young faculty members had patient care duties in more competitive markets than in less competitive markets. The authors conclude that "increased competitiveness of health care markets seems to hinder the capacity of academic health centers to conduct clinical research and to foster the careers of young clinical faculty."

These findings raise questions as to where the funds for clinical research that might be lost due to the changing health care market are to come from in the future, as well as the patients to participate in clinical research experiments.

Distribution of R&D Funds Across Academic Institutions⁸

Most academic R&D is now, and has been historically, concentrated in relatively few of the approximately 3,600 higher education institutions in the United States. In fact, if all such institutions were ranked by their 1995 R&D expenditures, the top 200 institutions would account for about 94 percent of R&D expenditures. In 1995:

♦ the top 10 institutions spent 17 percent of total academic R&D funds (\$3.7 billion),

- ♦ the top 20 institutions spent 29 percent (\$6.5 billion),
- ♦ the top 50 spent 55 percent (\$12.10 billion), and
- ♦ the top 100 spent 78 percent (\$17.2 billion).¹⁰

This historic concentration of funds, however, has diminished somewhat during the past decade. In 1985, the top 10 institutions received about 19 percent of the funds. The decline in this group's share is approximately matched by the increase in the share of those institutions in the group below the top 100—this group's share increased from 19 to 22 percent of total academic R&D funds. The institutions ranked from 11 to 100 received similar shares in 1995 as in 1985 (between 61 and 62 percent). (See appendix table 5-4.)

⁸The Carnegie Foundation for the Advancement of Teaching classified about 3,600 degree-granting institutions as higher education institutions in 1994. (See chapter 2, "Characteristics of U.S. Higher Education Institutions," for a brief description of the Carnegie categories.) These higher education institutions include four-year colleges and universities, two-year community and junior colleges, and specialized schools such as medical and law schools. Not included in this classification scheme are more than 7,000 other postsecondary institutions (secretarial schools, auto repair schools, etc.).

⁹See Geiger and Feller (1995) for an interpretation of the patterns of dispersion of academic research funds among universities.

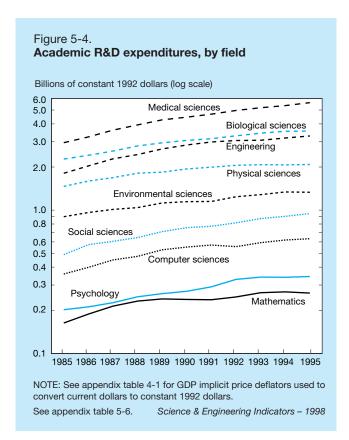
¹⁰These percentages exclude the Applied Physics Laboratory (APL) at the Johns Hopkins University. With an estimated \$447 million in total expenditures and \$434 million in federally financed expenditures in fiscal year 1995, APL performs about 57 percent of the university's R&D. Although not officially classified as an FFRDC, APL essentially functions as one. Its exclusion therefore provides a better measure of the distribution of academic R&D dollars and the ranking of individual institutions.

Expenditures by Field and Funding Source¹¹

The overwhelming share of academic R&D expenditures in 1995 went to the life sciences, which accounted for 55 percent of total academic R&D expenditures, 53 percent of federal academic R&D expenditures, and 57 percent of nonfederal academic R&D expenditures. Within the life sciences, medical sciences accounted for 27 percent of total academic R&D expenditures and biological sciences for 17 percent. The next largest block of total academic R&D expenditures was for engineering—16 percent in 1995. (See appendix table 5-5; for detailed data on expenditures over time by S&E field, see appendix table 5-6.)

Between 1985 and 1995, academic R&D expenditures for all fields combined grew at an average annual rate of 5.2 percent in constant 1992 dollars. (See figure 5-4.) Funding for the social sciences grew fastest during the decade, increasing at an average annual rate of 6.8 percent in constant dollars. Within the social sciences, political science was the fastest growing fine field (8.1 percent) and economics the slowest growing (4.2 percent). Engineering grew second fastest, increasing at an average annual rate of 6.2 percent. Within engineering, aeronautical/astronomical and civil engineering grew the fastest (7.5 percent and 7.4 percent, respectively) and electrical engineering the

¹¹The data in this section are drawn from NSF's Scientific and Engineering Expenditures at Universities and Colleges Survey. For various methodological reasons, parallel data by field from the NSF Survey of Federal Obligations to Universities and Colleges do not necessarily match these numbers.



slowest (5.5 percent). Academic R&D expenditure growth was slowest in the physical sciences, averaging 3.6 percent. Within the physical sciences, physics and chemistry grew the slowest (2.5 percent and 2.9 percent, respectively) and astronomy the fastest (8.8 percent). All other S&E fields averaged rates of annual growth between 4 and 6 percent.

The distribution of federal and nonfederal funding of academic R&D in 1995 varied by field. (See appendix table 5-5.) For example, the Federal Government supported about 78 percent of academic R&D expenditures in both physics and atmospheric sciences, but only 32 percent of academic R&D in economics and 30 percent in the agricultural sciences.

The declining federal share in support of academic R&D is not limited to particular S&E disciplines. Rather, the federally financed fraction of support for *each* S&E field was lower in 1995 than in 1975. (See appendix table 5-7.) The most dramatic decline occurred in the social sciences (55 percent in 1975 to 39 percent in 1993); the smallest declines were in the computer sciences and environmental sciences (74 to 70 percent and 71 to 67 percent, respectively). The overall decline in federal share also holds for all the reported S&E fine fields except the agricultural sciences (which increased slightly from 29 to 30 percent). Many fields have experienced slight increases in federal share during the first half of the 1990s.

Federal Support of Academic R&D

Top Agency Supporters

Federal obligations for academic R&D are concentrated in three agencies: the National Institutes of Health, the National Science Foundation, and the Department of Defense. Together, these agencies are estimated to have provided approximately 82 percent of total federal financing of academic R&D in 1997, as follows:

- ♦ NIH—57 percent,
- ♦ NSF—15 percent, and
- ♦ DOD—10 percent.

An additional 14 percent of the 1997 obligations for academic R&D are provided by the National Aeronautics and Space Administration (NASA, 6 percent); the Department of Energy (DOE, 5 percent); and the Department of Agriculture (USDA, 3 percent). (See appendix table 5-8.) Federal obligations for academic research are concentrated similarly to those for R&D. (See appendix table 5-9.) There are some differences, however, since some agencies place greater emphasis on development (DOD), while others place greater emphasis on research (NSF).

During the 1990s, NASA's funding of academic R&D increased most rapidly, with an estimated average annual growth rate of 3.1 percent per year in constant 1992 dollars. The next highest rates of growth were experienced by NIH (2.7 percent) and NSF (1.9 percent). Between 1996 and 1997, total federal obligations for federal R&D are estimated to decline in constant dollars. Only NSF (by 3 percent) and DOE

Industry-University Ties and the Conduct and Dissemination of Academic Research

Growing industry support of academic R&D and expanding industry-university ties have given rise to two concerns: that universities' commitment to basic research may be undermined, and that free and open disclosure of academic research results may face restrictions. In a chapter in *Challenge to the Research University*, Wesley M. Cohen and coauthors Richard Florida, Lucien Randazzese, and John Walsh (1998) examine these issues in light of recent research. Key hypotheses and research results are summarized here.

A number of indicators suggest that industry-university research relations have indeed expanded substantially since the mid-1970s. The industry share of academic R&D has more than doubled during that time. In 1990, 1,056 university-industry R&D centers—nearly 60 percent of them established during the 1980s—spent \$2.9 billion on R&D. Patenting at the top 100 research universities expanded from 177 awards in 1974 to 1,486 in 1994; 200 offices administered technology transfer and licensing activities in 1990, compared with 25 in 1980. The authors also cite anecdotal evidence of an increase in spinoffs or faculty participation in new firms, along with increasing equity shares held by universities in firms spun off to commercialize academic research outputs.

Different incentives motivate firms and universities to form these partnerships. University initiatives led to the establishment of almost three-quarters of the university-industry research centers—61 percent originating with faculty, 12 percent with administrators.

The authors hypothesize that firms' profit incentive may incline them to control access to results of research they have sponsored and that it may also focus them on applied rather than basic research. This conflicts with academics' priority—the free and open publication and dissemination of their research findings, which is the source of academic eminence and the basis for further scientific inquiry. Thus, widespread industry-university collaborations may induce shifts toward more applied academic research and restricted disclosure of academic research findings. Others have suggested that firms may shift some of their internal fundamental research to academia.

Cohen, Florida, Randazzese, and Walsh provide some evidence for their hypotheses. On the issue of restricted access to research results, 53 percent of a national sample of university-industry research centers allowed firms to request publication delays; 35 percent permitted deleting of information prior to submission for publication (Cohen, Florida, and Goe 1994). For 117 centers whose missions most strongly supported an orientation toward industry needs, these numbers were higher: publication delays, 63

percent; deletion of information, 54 percent. Moreover, study respondents reported restrictions on faculty communications with faculty and staff at the home university (21 percent), with those at other universities (29 percent), and with the general public (42 percent). These numbers are about 15 percentage points higher for centers strongly oriented toward industry needs. Cohen, Florida, Randazzese, and Walsh note, however, that although publication and communications restrictions may be contained in agreements, they are not necessarily always implemented. They also indicate that implementation of such restrictions may undermine key channels through which academic research affects industrial R&D.

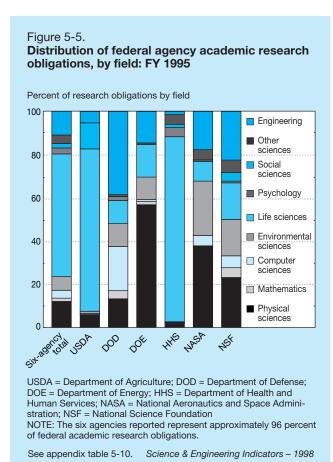
Similarly, in a sample of companies supporting academic life science research, 82 percent stipulated that research results could be kept confidential pending a patent application; 47 percent had agreements permitting at least occasional embargo of results beyond the patent application (Blumenthal et al. 1996). In a survey of academic technology managers, 39 percent reported having agreements that placed restrictions on faculty sharing information regarding R&D breakthroughs with departmental or other center faculty. In that study, 79 percent of the technology managers and 53 percent of faculty with experience in interacting with firms indicated that firms had asked for R&D results to be delayed or kept from publication (Rahm 1995). Cohen, Florida, Randazzese, and Walsh note that the existence of spinoff companies raises the same set of questions and speculate that similar pressures may apply to the composition and disclosure of research—the main difference being that they would be generated by the faculty, rather than externally.

The evidence regarding a displacement of basic by applied research is less clear. Several studies have found an empirical association between greater faculty-industry interaction and more applied research (Rahm 1994, Morgan 1993 and 1994); another survey found that stronger center mission focus on improving industry activities was associated with lower shares of center effort going toward basic research (Cohen, Florida, and Goe 1994). However, while acknowledging the difficulty of drawing a boundary between basic and applied research, Cohen, Florida, Randazzese, and Walsh note that university-reported NSF data on the composition of academic R&D fail to reflect a shift away from basic research, which constituted 67 percent of academic R&D during 1980-83 and 66 percent during 1990-93. They point out that industry support may be attracting faculty already inclined toward applied research, rather than inducing others to shift away from basic research.

(by 0.5 percent) are expected to increase their academic R&D obligations in 1997.

Agency Support by Field

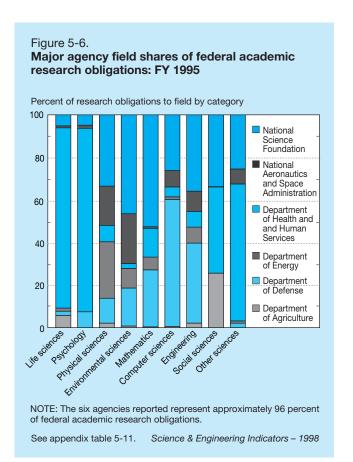
Federal agencies emphasize different S&E fields in their funding of academic research. Several agencies concentrate their funding in one field—the Department of Health and Human Services (HHS) and USDA focus on the life sciences, while DOE concentrates on the physical sciences. Other agencies—NSF, NASA, and DOD have more diversified funding patterns. (See figure 5-5.) Even though an agency may place a large share of its funds in one field, it may not be an important contributor to that field, particularly if it doesn't spend much on academic research. (See figure 5-6.) NSF is the lead funding agency in the physical sciences (34 percent of total funding), mathematics (53 percent), and the environmental sciences (47 percent). DOD is the lead funding agency in the computer sciences (60 percent) and in engineering (38 percent). HHS is the lead funding agency in the life sciences (85 percent), the social sciences (41 percent), and psychology (86 percent). Within S&E fine fields, other agencies take the leading role—DOE in physics (46 percent), USDA in agricultural sciences (99 percent) and economics (75 percent), and NASA in astronomy (68 percent) and in both aeronautical (60 percent) and astronautical (64 percent) engineering.



The Spreading Institutional Base of Federally Funded Academic R&D¹²

Despite fluctuations over the past couple of decades, the number of academic institutions receiving federal support for their R&D activities has increased, rising from 555 in 1975, to 648 in 1985, and to 882 in 1995. (See text table 5-1.) Since most research and doctorate-granting institutions were already receiving federal support in 1975, almost the entire increase has occurred among comprehensive; liberal arts; two-year community, junior, and technical; and professional and other specialized schools. The number of such institutions receiving federal support has just about doubled over the 1975-95 period, rising from 335 in 1975, to 422 in 1985, and to 654 in 1995. These institutions are also receiving a larger share of the reported federal obligations for R&D to universities and colleges now than in the past—11 percent in 1995, compared to 7 percent in 1985.

¹³See NSB (1993) for a more comprehensive discussion of the spreading institutional base, which includes developments in individual S&E fields. The field analysis cannot be extended after 1993 because DOD no longer provides detailed academic R&D funding by field.



¹²The data in this section are drawn from NSF's Federal Support to Universities, Colleges, and Selected Nonprofit Institutions Survey. The survey collects data on federal R&D obligations to individual U.S. universities and colleges from the 15 federal agencies that account for virtually all such obligations. For various methodological reasons, data reported in this survey do not necessarily match those reported in the Scientific and Engineering Expenditures at Universities and Colleges Survey.

Text table 5-1.

Number of academic institutions receiving federal R&D support

	All academic institutions	Research and doctorate-granting institutions ^a	Other institutions ^a
1975	. 555	220	335
1985	. 648	226	422
1990	. 746	227	519
1994	. 890	227	663
1995	. 882	228	654

^aThese are the institutional categories used by the Carnegie Foundation for the Advancement of Teaching. See chapter 2, "Characteristics of U.S. Higher Education Institutions," for information on these categories. "Other institutions" are all Carnegie-

classified institutions except research and doctorate-granting institutions.

SOURCES: National Science Foundation, Science Resources Studies Division, Federal Support to Universities, Colleges, and

Nonprofit Institutions, Fiscal Year 1995, Detailed Statistical Tables,

forthcoming (Arlington, VA: 1998); and unpublished tabulations.

Science & Engineering Indicators – 1998

Recently, legislation has been passed that requires federal agencies to demonstrate the impact of their programs. See "GPRA: Instituting Accountability in Federal Funding of Academic R&D" for a discussion of how this legislation hopes to improve federal planning and management, increase accountability for and assessment of results, and provide better information for congressional and agency decisionmaking.

Academic R&D Facilities and Instrumentation¹⁴

Facilities Overview¹⁵

Total Space. Between 1988-89 and 1996-97, total academic science and engineering research space increased by almost 22 percent, from about 112 million to 136 million net assignable square feet (NASF). (See appendix table 5-12.) Planned construction expenditures for academic research facilities are expected to reach \$3.1 billion (in constant dol-

lars) in 1996-97.¹⁷ If this planned funding materializes, it will reverse the recent downward trend that began between 1990-91 and 1992-93. Construction expenditures in constant dollars peaked at around \$3.4 billion in 1990-91, dropped to \$3.0 billion in 1992-93, and dropped again to \$2.8 billion in 1994-95. (See appendix table 5-13.)

New Construction. New construction projects initiated between 1986 and 1995 were expected to produce over 52 million square feet of research space when completed—the equivalent of about 39 percent of estimated existing research space. A significant portion of this new research space likely replaces obsolete or inadequate space rather than actually increases existing space: this is indicated by the fact that the total amount of research space increased by 24 million NASF between 1988-89 and 1996-97, while new construction initiated between 1988-89 and 1994-95 was expected to increase by 43 million NASF. Planned new construction projects initiated in 1996-97 are expected to produce just under 11 million square feet of new research space. (See appendix table 5-12.)

Repair and Renovation. Planned expenditures for major repair/renovation (i.e., projects costing over \$100,000) of academic research facilities are expected to reach \$1.3 billion (in constant dollars) in 1996-97. These expenditures also increased between 1992-93 and 1994-95, rising from \$905 million to \$1.1 billion in constant dollars. (See appendix table 5-13.) While expenditures for major repair/renovation increased between 1992-93 and 1994-95, expenditures for smaller S&E research facility repair/renovation projects (those costing less than \$100,000) decreased—dropping during this period from \$261 million to \$135 million in constant dollars. Projects initiated between 1986 and 1995 were expected to result in the repair/renovation of over 55 million square feet of research space. 18 Planned projects initiated in 1996-97 are expected to result in the repair/renovation of an additional 13.7 million square feet of research space. (See appendix table 5-12.)

Repair/renovation expenditures as a proportion of total capital expenditures (construction and repair/renovation) have increased steadily since 1990-91, rising from 25 percent of all capital project spending to 30 percent by 1994-95. Forty-three percent of all research-performing colleges and universities are planning to undertake some type of repair/renovation costing over \$100,000 during 1996-97; 29 percent are planning to undertake construction projects during the same period.

Sources of Funds. Since 1986, there have been some shifts in the significance of various funding sources for the construction and repair/renovation of S&E research space. While the relative rankings of these sources have remained fairly

¹⁴Data on facilities and instrumentation are taken primarily from several NSF-supported surveys. Although terms are defined specifically in each survey, in general facilities expenditures (1) are classified as "capital" funds, (2) are fixed items such as buildings, (3) often cost millions of dollars, and (4) are not included within R&D expenditures as reported here. Equipment and instruments (the terms are used interchangeably) are generally movable, purchased with current funds, and included within R&D expenditures. Because the categories are not mutually exclusive, some large instrumentation systems could be classified as either facilities or equipment.

¹⁵The information in this section is derived from NSF's biennial Survey of Scientific and Engineering Research Facilities at Universities and Colleges. For more detailed data and analysis on academic S&E research facilities (for example, by institution type and control), see NSF (1996c).

¹⁶"Research space" here refers to the net assignable square footage of space within facilities (buildings) in which S&E research activities take place. Multipurpose space within those facilities, such as an office, is prorated to reflect the proportion of use devoted to research activities. NASF data are reported for combined years (e.g., 1987-88 data are for fiscal years 1987 and 1988.

¹⁷Current dollars have been adjusted to 1995 constant dollars using the U.S. Bureau of the Census's Composite Fixed-Weighted Price Index for Construction.

¹⁸It is difficult to report repaired/renovated space in terms of a percentage of existing research space. As collected, the data do not differentiate between repair and renovation, nor do they provide an actual count of unique square footage that has been repaired or renovated. Thus, any proportional presentation might include double or triple counts, since the same space could be repaired (especially) or renovated several times.

GPRA: Instituting Accountability in Federal Funding of Academic R&D

In response to the Clinton Administration's effort to move toward a government that works better and costs less, Congress passed the Government Performance and Results Act of 1993 (GPRA). GPRA aims to shift the focus of federal agencies away from traditional concerns such as staffing and the level of services provided and toward results. Specifically, GPRA looks to improve federal planning and management, increase accountability for and assessment of results, and provide better information for congressional and agency decisionmaking. To accomplish these and related goals, GPRA requires every federal agency to prepare detailed, multiyear strategic plans; annual performance plans; and annual performance reports. These documents give agencies formal tools with which to set forth goals, prepare plans to meet those goals, and to assess and measure progress and accomplishments on a regular and systematic basis.

GPRA poses a particular challenge for those agencies that must assess the scientific research programs they fund. In fact, the General Accounting Office (GAO) has found that measuring the discrete contribution of a federal initiative to a specific program result is particularly challenging for regulatory programs; scientific research programs; and programs that deliver services to taxpayers through third parties, such as state and local governments (U.S. GAO 1997a). Regarding research programs, GAO points out that the amount of money spent on R&D has been used as the primary indicator of how much research is being performed in a given area, but that such an *input* indicator does not provide a good indication of the *outcomes* (results) of the research. In a recent report, GAO notes that:

...experts in research measurement have tried for years to develop indicators that would provide a measure of the results of R&D. However, the very nature of the innovative process makes measuring the performance of science-related projects difficult. For example, a wide range of factors determine if and when a particular R&D project will result in commercial or other benefits. It can also take many years for a research project to achieve results... Experiences from pilot efforts made under the Government Performance and Results Act have reinforced the finding that output measures are highly specific to the management and mission of each federal agency and that no single indicator exists to measure the results of the research (U.S. GAO 1997b).

The Subcommittee on Research of the Committee on Fundamental Science, which operates within the President's Office of Science and Technology Policy, has been working with federal research agencies to establish a broad framework for GPRA implementation in the assessment of fundamental science programs. The subcommittee states that:

The central issue in assessing fundamental science lies in defining the goal against which progress is measured. The Administration's science policy statement, "Science in the National Interest" [Clinton and Gore 1994], establishes that goal as leadership across the frontiers of scientific knowledge. This is the critical measure for assuring that American scientists are expanding the knowledge base at the leading edge...

Leadership evaluation does not entail simplistic numerical ranking of national programs. Our national interest in leadership rests in having our research and educational programs perform at the cutting edge—sometimes in competition, but often in explicit collaboration, with scientists from other nations. This goal is the principal guideline for government stewardship of science in the national interest. It is an enabling or intermediate objective with respect to the overarching goals of improved health and environment, national security, economic prosperity, and quality of life . . . Science drives progress toward the over-arching national goals over a long time period and only as part of a larger enterprise requiring a complex interplay of science and technological innovation with fiscal, regulatory, intellectual property rights, and trade policies. Consequently, the enabling goal of maintaining broad scientific leadership is that which guides the management and assessment of today's science investments. It provides the principal yardstick for GPRA assessment strategies for fundamental science programs (NSTC 1996).

The subcommittee concludes that retrospective evaluation will have to be the main assessment tool and that it will have to be updated periodically to examine the link between fundamental science and the overarching national goals. A final concern related to GPRA's implementation in an R&D environment is that it may cause science agencies to focus on processes and process issues and to set inflexible process goals. Such an approach is likely to interfere with the conduct of research, which must be flexible and changeable to be effective.

Agencies are still struggling with GPRA's requirements in this arena, puzzling over how to balance the need for planning with the need for flexibility; the need for short-term measures with the reality of accomplishments that will only be realized in the long term. Despite these challenges, GPRA is an important requirement and can be an opportunity for government agencies, Congress, and the university community to better communicate to the public the value of investments in R&D and education.

constant—with state and local governments providing the largest share of support, followed by institutional funds—the proportions of funding for which they account have changed, sometimes dramatically. Most strikingly, the proportion of funds provided through private donations has declined. In 1986-87, this source accounted for about 20 percent of construction and repair/renovation funding; by 1994-95, however, its share had declined to about 12 percent. This reflects a drop in private donations to public institutions. Also of note, other debt grew from a 0.2 percent share in 1986-87 to account for 5.9 percent of funds in 1994-95; this reflects the increased importance of this funding source to private institutions. During the period, funds from federal sources¹⁹ and from taxexempt bonds first grew in significance—the former increasing from 6 percent in 1986-87 to about 14 percent in both 1990-91 and 1992-93, and the latter from just below 16 percent to about 21 percent in 1990-91—and then dropped to account for smaller overall shares in 1994-95 (about 8 and 13 percent, respectively). (See appendix table 5-14.)

In general, the major sources of funds for new construction are not the same as those for repair/renovation. About 43 percent of the funds for new construction come from state and local governments, with about 16 percent from institutional funds. The significance of these funding sources is reversed for repair/renovation. About 41 percent of the funds for repair/renovation come from institutional funds, and 25 percent from state and local funds. The proportion of repair/renovation funds from the Federal Government increased from 6 percent in 1988-89 to slightly above 10 percent in 1994-95, while the federal proportion for new construction decreased from 14 to 8 percent during the same period. (See appendix table 5-14.)

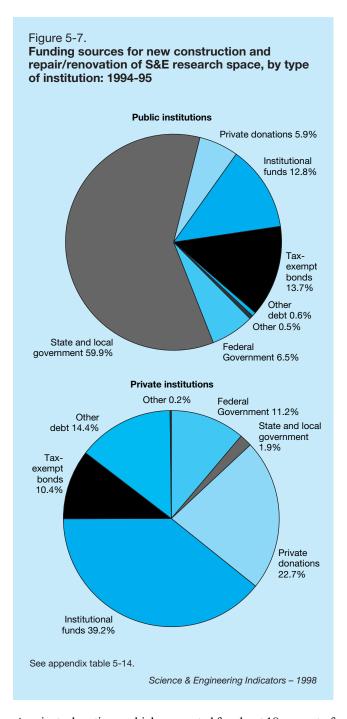
Public and private institutions draw upon substantially different sources to fund the construction and repair/renovation of research space. (See figure 5-7.) Public institutions rely primarily on:

- ♦ state and local funding, which accounted for 46 percent of their total funding in 1992-93 and 60 percent in 1994-95;
- tax-exempt bonds, which accounted for 18 percent of their total funding in 1992-93 and 14 percent in 1994-95; and
- institutional funds, which accounted for 14 percent of their total funding in 1992-93 and 13 percent in 1994-95.

The Federal Government share declined from just above 14 percent in 1992-93 to below 7 percent in 1994-95.

Private institutions, for their part, rely primarily on:

 institutional funds, which accounted for 32 percent of their total funding in 1992-93 and 39 percent in 1994-95; and



♦ private donations, which accounted for about 18 percent of their total funding in 1992-93 and 23 percent in 1994-95.

A significant shift in the importance of tax-exempt bonds as a funding source for private institutions occurred between 1992-93—when they accounted for about 23 percent of total funding—and 1994-95, when they dropped to only about 10 percent. The decline in the importance of tax-exempt bonds over this period was roughly offset by an increase in the share of other debt from about 4 percent to about 14 percent. (See appendix table 5-14.)

Condition and Adequacy. Reported data suggest little change in the condition of academic S&E research space be-

¹⁹The actual amount of federal funds devoted to construction and repair/renovation is likely to be underrepresented because substantial federal funding for this purpose is received as overhead on federal grants and contracts. These funds are counted as institutional funds and may be used for construction and repair/renovation of research facilities.

Text table 5-2. Condition of academic science and engineering research facilities (Percentages)

Assessed condition of academic institutions' research space	1988	1990	1992	1994	1996ª
Suitable for use in most scientifically sophisticated research Effective for most uses, but not most scientifically sophisticated	23.9 36.8	25.9 35.3	26.8 34.7	26.4 32.8	37.2
Requires limited repair/renovation to be used effectively	23.5	23.3	22.6	23.1	43.9
Requires major repair/renovation to be used effectively ^b	15.8 NA	15.5 NA	12.8 3.1	12.9 4.1	18.5

NA = not available

NOTE: Percentages may not total 100 because of rounding.

^aIn 1996, the survey response categories were changed to: "suitable for the most scientifically competitive research"; "effective for most levels of research, but may need limited repair/renovation"; and "requires major renovation or replacement to be used effectively."

^bThe data for 1988 and 1990 in this category include space requiring replacement.

°This category was first used in the 1992 survey.

See appendix table 5-15.

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tween 1988 and 1994.²⁰ (See text table 5-2.) Specifically, about a quarter of this space was rated as suitable for use in the most scientifically sophisticated research; about a third was judged to be effective for most uses, but not most scientifically sophisticated; less than a quarter was reported as needing limited repair/renovation; and about a sixth was said to require major repair/renovation or replacement.

The 1996 survey responses cannot be readily compared to these earlier results because the wording and response choices have been changed. Specifically, the number of response categories has been reduced from five to three: suitable for the most scientifically competitive research; effective for most levels of research, but may need limited repair/renovation; and requires major renovation or replacement to be used effectively. This change essentially resulted in a shifting of about one-third of the space characterized in 1994 as "effective for most uses, but not most scientifically sophisticated," to the new category "suitable for the most scientifically competitive research"; and the other two-thirds to the new category "effective for most levels of research, but may need limited repair/renovation."

Unmet Needs. Determining what universities and colleges need with regard to S&E research space is a complex matter. In order to measure real as opposed to speculative needs, the 1994 facilities survey adopted a new approach to this issue. Faculty respondents were asked to report whether an approved institutional plan existed that included any deferred space needing new construction or repair/renovation.²¹ Respondents were then asked to estimate, for each S&E field, the costs of such

construction and repair/renovation projects. The 1996 survey expanded on this question by asking institutions to report separately the construction and repair/renovation costs for projects included in such plans, as well as for projects not included.

In 1994, a total of 40 percent of all research-performing universities and colleges had an approved institutional plan that included construction or repair/renovation projects that were either deferred and unfunded.²² The estimated cost of these projects in constant dollars was \$6.2 billion: \$4.4 billion for new construction and \$1.8 billion for repair/renovation. In 1996, 44 percent of research-performing institutions reported having an approved institutional plan that included construction or repair/renovation projects that were needed but that had to be deferred because funds were not available. These plans cited \$7.4 billion of deferred capital project expenditures in constant dollars—\$4.6 billion for new construction and \$2.8 billion for repair/renovation. This total represents a \$1.2 billion increase in deferred capital project costs between 1994 and 1996, the majority for repair/renovation (\$970 million) and the remainder in deferred construction costs (\$259 million). Another 11 percent of research-performing institutions identified \$1.9 billion of needed deferred capital project expenditures that were not included in an institutional plan—\$1.0 billion for new construction and \$0.9 billion for repair/renovation.

Facilities by S&E Field

There was little change in the distribution of academic research space across S&E fields between 1988 and 1996. (See appendix table 5-12.) About 90 percent of current academic research space continues to be concentrated in six fields:

²⁰Since the Survey of Scientific and Engineering Research Facilities at Universities and Colleges from which the results are derived is a sample survey, the small changes reported are not likely to be statistically significant.

²¹Four criteria were used to define deferred space in the 1994-95 survey: (1) the space must be necessary to meet the critical needs of current faculty or programs, (2) construction must not have been scheduled to begin during fiscal years 1994-95, (3) construction must not have funding set aside for it, and (4) the space must not be for developing new programs or expanding the number of faculty.

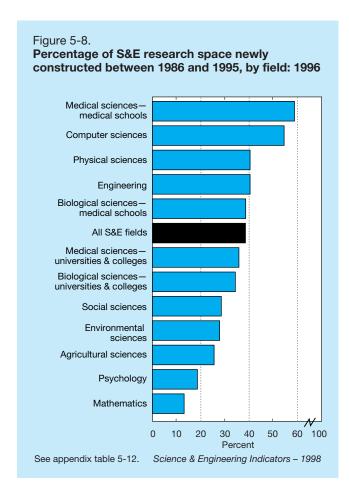
²²The other 60 percent of the institutions surveyed might have needed new construction or repair/renovation but didn't have an approved institutional plan to that effect. Certain classes of institutions (smaller institutions, historically black colleges or universities) were less likely to have either a plan or a plan that includes deferred needs. Of those surveyed, the top 100 institutions in terms of research expenditures were most likely to have an approved institutional plan (60 percent), and the nondoctorate-granting institutions were least likely (26 percent).

- ♦ the biological sciences (21 percent in 1988 and 22 percent in 1996),
- ♦ the medical sciences (17 percent in 1988 and 18 percent in 1996),
- engineering (from 14 to 16 percent),
- ♦ the agricultural sciences (16 percent in both years),
- ♦ the physical sciences (from 14 to 13 percent), and
- ♦ the environmental sciences (from 6 to 5 percent).

The ratio of planned new construction during the 1986-95 period to existing research space differs across S&E fields.²³ More than half of the research space for medical sciences at medical schools and for computer sciences appears to have been built in the 1986-95 period. In contrast, less than 20 percent of the research space for mathematics and psychology appears to have been newly constructed during this period. (See figure 5-8.)

Condition and Adequacy. The condition of academic research space also differs across S&E fields. In 1996, the agricultural sciences reported the largest proportion among all S&E fields—about 24 percent—of research space in need of major repair/renovation or replacement. Other fields with higher than average needs for repair/renovation or replace-

²³As noted earlier, the actual percentage of existing space that may have been repaired/renovated is not known because some space may have been repaired/renovated more than once.



ment are the physical sciences (19 percent of total research space), the environmental sciences (19 percent), and the medical sciences both in universities and colleges (21 percent) and in medical schools (20 percent). In contrast, major repair/renovation or replacement was needed for only 13 percent of the total research space in the social sciences, 12 percent in psychology, 10 percent in mathematics, and less than 8 percent in the computer sciences. No particular trends have emerged as yet with respect to changes over time in repair/renovation needs across S&E fields. (See appendix table 5-15.)

In 1994, 40 percent or more of all institutions surveyed indicated inadequate amounts of research space in engineering, the physical sciences, the biological sciences outside of medical schools, and the medical sciences in medical schools. (See appendix table 5-16.) One-third or less of all institutions surveyed indicated inadequate amounts of S&E research space in the environmental sciences, the agricultural sciences, mathematics, psychology, and the social sciences. In 1996, 40 percent or more of all institutions indicated inadequate amounts of research space in all S&E fields except mathematics. More than half of all institutions indicated inadequate amounts of research space in engineering, the physical sciences, the biological sciences outside of medical schools, the medical sciences (both in and outside of medical schools), and the agricultural sciences. It is unclear how much of the change that occurred over the two periods is due to changes in the survey questionnaire rather than to an increasing inadequacy of research space.²⁴

Unmet Needs. Deferred and unfunded needs existed in all S&E fields in 1996. The fields most frequently cited as having an unfunded need for new construction of research facilities as part of an institutional plan were the agricultural sciences (21 percent), engineering (19 percent), the medical sciences in medical schools (14 percent), and the physical sciences (13 percent). (See text table 5-3.) Unfunded need for repair/renovation projects reported in an institutional plan was indicated most strongly in the biological and medical sciences within medical schools (31 and 30 percent, respectively). An additional set of institutions reported deferred capital projects for both new construction and repair/renovation without an institutional plan in all S&E fields, with a larger percentage of institutions in each field reporting a need for repair/renovation projects than for new construction projects.

In four fields, estimated expenditures for needed capital projects (new construction plus repair/renovation) were over \$1 billion (including those identified in an institutional plan or not in a plan): the physical sciences (\$1.9 billion), engineering (\$1.5 billion), the biological sciences outside of medical schools (\$1.4 billion), and the medical sciences in medical schools (\$1.3 billion). (See appendix table 5-17.)

²⁴Again, the response choices were changed in 1996 compared to previous survey years. In 1994 and earlier, respondents were asked to rate the amount of research space in each field as either adequate, generally adequate, inadequate, nonexistent but needed, or not applicable or not needed. In 1996, these choices were narrowed down to three: adequate; inadequate, including insufficient; or not applicable or not needed.

Text table 5-3.

Percentage of institutions with deferred capital projects to construct and/or repair/renovate S&E research facilities, by field, with and without an institutional plan: 1996

	Percentage of institutions ^a								
	Wi	th plan	Without plan						
Field	Construction	Repair/renovation	Construction	Repair/renovation					
Physical sciences	13	22	3	12					
Mathematics	2	10	3	6					
Computer sciences	2	8	6	6					
Environmental sciences	5	18	4	5					
Agricultural sciences	22	19	11	14					
Biological sciences									
Universities & colleges	10	17	5	14					
Medical schools	10	32	3	10					
Medical sciences									
Universities & colleges	10	13	6	12					
Medical schools	14	30	3	12					
Psychology	2	7	3	7					
Social sciences	3	7	4	10					
Engineering	21	26	4	9					

^aPercentage of all responding institutions with research space in the relevant S&E field.

SOURCE: National Science Foundation, Science Resources Studies Division, Scientific and Engineering Research Facilities at Universities and Colleges: 1996, NSF 96-326 (Arlington, VA: 1996).

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Instrumentation

Expenditures.²⁵ In 1995, just over \$1.2 billion in current fund expenditures was spent for academic research instrumentation. Over 80 percent of these expenditures were concentrated in three fields: the life sciences (38 percent), engineering (23 percent), and the physical sciences (19 percent). (See figure 5-9.)

Between 1985 and 1995, current fund expenditures for academic research instrumentation first increased—growing at an average annual rate of 6.5 percent between 1985 and 1989—then dipped—dropping about 2 percent a year for the next four years—before recovering and growing by 3.6 percent from 1993 to 1994 and by 9.6 percent from 1994 to 1995 (in constant 1992 dollars). There were variations in growth patterns during this period among S&E fields. (See appendix table 5-18.)

Federal Funding. Federal funds for instrumentation are generally received either as part of research grants—thus enabling the research to be performed—or as separate instrumentation grants, depending on the funding policies of the particular federal agencies involved. The importance of federal funding for research instrumentation varies by field. In 1995, the social sciences received about 40 percent of their research equipment funds from the Federal Government. In contrast, federal support accounted for over 60 percent of in-

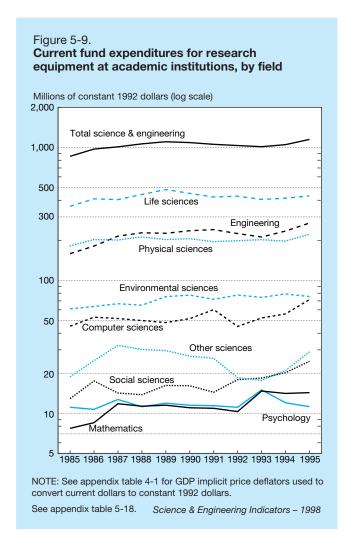
strumentation funding in the physical sciences, computer sciences, environmental sciences, psychology, and engineering.

Since 1985, the share of research instrumentation expenditures funded by the Federal Government has declined—although not steadily—dropping from 64 to 59 percent. This overall pattern masks different trends in individual S&E fields. In one field—the environmental sciences—federal support actually rose, albeit very slightly, accounting for just below 68 percent of the field's instrumentation support in 1985 and just above 68 percent in 1995. Two other fields experienced sharp declines in federal support during this decade. The federal share for mathematics instrumentation dropped from 82 to 59 percent, and the share for computer sciences instrumentation dropped from 83 to 62 percent.

R&D Equipment Intensity. R&D equipment intensity is the percentage of total annual R&D expenditures from current funds devoted to research equipment. This proportion has declined since 1986, when research equipment accounted for 7.2 percent of total R&D expenditures. (See appendix table 5-19.) By 1993, R&D equipment intensity had dropped to 5.2 percent; it has since increased—slightly—to 5.6 percent in 1995.

R&D equipment intensity varies across S&E fields. It tends to be higher in the computer sciences (11.3 percent in 1995), physical sciences (10.6 percent), and engineering (8.2 percent); and lower in the social sciences (2.6 percent), psychology (3.3 percent), and life sciences (3.8 percent). This disparity is probably the result of the latter three fields using less equipment and/or less expensive

²⁵Data used here are from the NSF Survey of Scientific and Engineering Expenditures at Universities and Colleges; they are limited to current funds expenditures for research instrumentation and do not include funds for instructional equipment. Current funds—as opposed to capital funds—are those in the yearly operating budget for ongoing activities. Generally, academic institutions keep separate accounts for current and capital funds.



instruments than the former three. Although the recent steady decline in R&D equipment intensity was not felt equally in all S&E fields, the 1986 figure was higher than that for 1995 in every field except mathematics. In that field, research equipment as a proportion of total R&D expenditures rose from 4.5 percent in 1986 to 5.4 percent in 1995. The data indicate, however, that the decline in R&D equipment intensity began to level off or reverse in 1993 for most S&E fields.

Stock, Condition, and Use. By congressional mandate, NSF has monitored academic research instrumentation status and needs since the early 1980s.²⁶ As of 1993 (the most recent year for which detailed instrumentation data are available), the 318 colleges, universities, and medical schools represented in the survey reported a combined estimated stock of 61,684 instruments, with an estimated aggregate original

purchase price of \$6.255 billion.²⁷ These instruments are categorized as shown in text table 5-4; their condition and usage were rated as follows:

- ♦ Maintenance and repair. Respondents rated 64 percent of the instruments as receiving above adequate to excellent maintenance/repair in 1993. Maintenance/repair was judged less than adequate or poor for only 8 percent of all instruments.
- ♦ State-of-the-art status. Overall, 27 percent of the instruments in research usage were rated as state of the art. An additional 63 percent were not state of the art, but were considered adequate for user needs. Only 9 percent were rated as inadequate.
- ♦ Average age. About 40 percent of the research instruments in use in 1993 had been acquired within the previous four years. Another 23 percent were over eight years old, and the average age of a research instrument was 5.8 years. (See appendix table 5-22.) Seventeen percent of all instruments costing under \$1 million were less than two years old in 1993, but only 7 percent of instruments over \$1 million were that new.
- ◆ Use. Sixty-four percent of the instruments reported in research use in 1993 were used exclusively for research. Most of the remainder (32 percent) were used predominantly for research with some instructional use. Only 4 percent of the total were used primarily for instruction with some research use.
- **Average number of users.** An average of 24.2 users per instrument was reported. Graduate students and postdoctorates assigned to the unit owning the instrument (i.e., the host unit) comprised the single largest category of user—an average of 8.5 per instrument. On average, there were also 3.5 faculty users from the host unit, 6.0 researchers from other units in the host institution, 4.5 researchers from outside the host institution, and 1.8 other users (primarily staff and undergraduates). In generaland not surprisingly—the higher an instrument's state-ofthe-art ranking, the greater the number of researchers using it. For instance, an average of 25.7 researchers used the state-of-the-art instruments, while an average of 24.2 used the instruments that were not state of the art but that were adequate for their research. An average of 20.5 researchers worked with instruments that were rated as inadequate.

Needs. In the 1994 Instrumentation Survey, most (69 percent) of the responding heads of academic departments and research facilities reported that their research instrumentation needs had increased since the last survey in 1992. A slim majority—58 percent—were satisfied with the overall capability of their existing instrumentation to support their faculty's research interests. The remaining 42 percent rated their

²⁶These data are collected via NSF's National Survey of Academic Research Instruments and Instrumentation Needs (Instrumentation Survey). NIH also provides funding for this survey. The survey consists of (1) questionnaires (now distributed every other year) that collect data on departmental equipment expenditures, equipment needs, and priorities; and (2) instrument data sheets (now distributed every four years) that collect detailed data from principal investigators on the condition, cost, usage, etc., of specific research instruments.

²⁷For a more complete discussion of the characteristics of academic R&D instrumentation by S&E field, see NSF (1997b and 1998c).

Text table 5-4. Research instrument stock, by category: 1993

			Percent	age of
Instrument category	Number	Cost (billion \$)	Total stock	Total cost
Computers and				
data handling	12,023	1.85	19	30
Chromatographs and				
spectrometers	13,789	1.29	22	21
Microscopy	5,597	0.55	9	9
Bioanalytical	10,205	0.47	17	7
Other	20,071	2.10	33	34
Electronics				
and lasers	6,958	0.43	11	7
Major instrument				
systems ^a	1,295	0.64	6	10

NOTE: Cost reflects original purchase price.

^aMajor instrument systems include research vessels, telescopes, and other major instruments such as nuclear reactors, wind/wave/water/shock tunnels, and major prototype systems. See appendix table 5-22 for a complete breakdown.

SOURCE: National Science Foundation, Science Resources Studies Division, "Total Stock of Academic Research Instruments Tops \$6 Billion in 1993," Data Brief, NSF 97-309 (Arlington, VA: 1997).

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research instrumentation as inadequate, and estimated the cost of the requisite upgrading at a total of \$1.438 billion.

All respondents were asked to list and estimate the combined cost of the three top-priority research instruments costing over \$20,000 their faculty most needed. Ten percent of the respondents said they had no immediate needs for additional instruments in this price range. For the others, the total combined cost of these items would be \$2.048 billion, of which \$942 million would be required for the top-priority item only. The primary reason cited for these top-priority research instruments was to upgrade unit capabilities—i.e., to perform experiments that the unit "cannot do now." The share from departments that reported inadequate overall instrumentation is an estimated cost of \$939 million for their top three priority items—or about 65 percent of the \$1.438 billion estimated cost to "fix" their units' overall instrumentation needs.²⁸

Academic Doctoral Scientists and Engineers

This section examines major trends over the 1973-95 time period regarding the composition of the academic S&E workforce, its primary activities (teaching vis-à-vis research), and the extent of its support by the Federal Government. For a discussion of the nature of the data used here, see "Data Sources: Nature, Problems, and Comparability."

The Academic Doctoral S&E Workforce²⁹

The total number of scientists and engineers in the U.S. labor force with doctoral degrees from U.S. universities has more than doubled over the past two decades, rising from about 215,000 in 1973 to 475,200 in 1995; the academic component increased from an estimated 118,000 to 217,500.³⁰ (See text table 5-5.) The rate of academic employment growth, though robust over much of the period, was lower than growth in other sectors. The growth rate for academic employment dropped from nearly 7 percent annually in the early 1970s to just under 1 percent from 1989 onward; consequently, the academic employment share declined from an estimated 55 percent in 1973 to 46 percent in the 1990s.

While the total number of academic doctoral scientists and engineers continued to rise from 206,700 in 1989 to 217,500 in 1995, the number of incumbents holding full-time faculty positions—full, associate, and assistant professors plus instructors—remained roughly stable at between 169,800 and 173,100. (See figure 5-10.) Consequently, the share of full-time faculty among all academic doctoral scientists and engineers declined to an all-time low of 79 percent. This drop continued a downtrend evident since the early

Text table 5-5.

Academic employment of doctoral scientists and engineers: Number, growth rate, and employment share

		oloyment usands)		ige annual of change	Academic share of	
	Total	Academia	Total	Academia	employment	
1973	215.0	118.0			55	
1975	250.8	134.1	8.02	6.60	53	
1977	277.2	145.5	5.12	4.15	52	
1979	306.7	155.4	5.19	3.35	51	
1981	336.1	167.1	4.69	3.72	50	
1983	363.1	176.2	3.93	2.68	49	
1985	395.7	190.3	4.39	3.93	48	
1987	416.5	196.0	2.60	1.48	47	
1989	447.3	206.7	3.63	2.70	46	
1991	468.6	210.6	2.36	0.92	45	
1993	460.5	213.8	-0.87	0.75	46	
1995	475.2	217.5	1.58	0.88	46	

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations.

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²⁸For a more complete discussion of academic instrumentation needs by S&E field and by major instrument category and field, see NSF (1996a).

²⁹The academic doctoral S&E workforce includes full, associate, and assistant professors and instructors—collectively defined throughout this section as faculty—lecturers, adjunct faculty, research and teaching associates, administrators, and postdoctorates.

³⁰The trend data in this section refer to scientists and engineers with doctorates from U.S. institutions, regardless of their citizenship status. Comparable trend data for Ph.D.-level scientists and engineers with degrees from non-U.S. institutions are not available. A 1993 U.S. Department of Education survey of academic faculty suggests that this component of the academic workforce numbers around 13,000.

Data Sources: Nature, Problems, and Comparability

The data used in this section to describe the employment, characteristics, and activities of academic doctoral scientists and engineers derive mainly from the Survey of Doctorate Recipients (SDR) and in part from the National Study of Postsecondary Faculty (NSOPF).

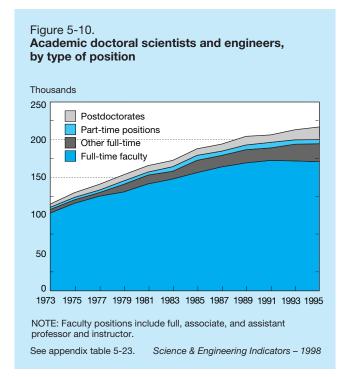
SDR is a sample survey conducted biennially since 1973 under the sponsorship of the National Science Foundation and several other federal agencies. The survey underwent several changes in 1991, and again from 1993 forward; these affect the comparability of data from these years with those of earlier periods. Through 1989, the sample included three major respondent segments: (1) recipients of S&E doctorates from U.S. institutions; (2) a small number of doctorate-holders in other fields who were working in S&E in the survey year; and (3) a small number of people with S&E doctorates from non-U.S. institutions.

Starting with the 1991 sample, only recipients of S&E doctorates from U.S. universities were retained, and persons over 75 years old were ruled out of scope. Further, sampling strata and sample size were reduced in an effort to improve response rates within budget constraints. Other changes in data collection also were introduced, most notably the use of computer-assisted telephone interviewing, which resulted in much higher response rates than had been attained previously. A 31-month interval elapsed between the 1989 and 1991 surveys instead of the usual 24 months;

the interval between the 1991 and 1993 surveys was 20 months.

Methodological studies to assess the full impact of these changes on overall estimates and individual data items remain to be conducted. Preliminary investigations suggest that SDR data permit analysis of rough trends, provided comparisons are limited to recipients of S&E doctorates from U.S. institutions. This has been done herein, with data structured in accordance with suggestions offered by the National Research Council's Office of Scientific and Engineering Personnel, which has conducted all of these surveys through 1995. Nevertheless, in the text and tables presented here, apparently interesting but small statistical differences should be treated with caution.

NSOPF is a sample survey that was conducted by the U.S. Department of Education in 1988 and 1993. The two NSOPF survey frames are not comparable. Those with no teaching duties in the fall semester of 1988 were considered out of scope, while the comparable group was included in the 1993 cycle. Internally consistent subsets can be constructed and compared across the two survey years, however. Because the NSOPF estimates of doctoral scientists and engineers agree quite well with those derived from SDR, and since NSOPF contains information on teaching activities that is unavailable from SDR, data from this survey have been used to supplement SDR information.



1970s, when this share had stood at 88 percent. Psychology and the physical, environmental, and life sciences experienced particularly substantial shifts toward nonfaculty employment, with full-time faculty percentages dropping by 10 or more points. Developments in the social sciences, mathematics, and engineering were somewhat less pronounced. (See appendix table 5-23.)

The number of incumbents in other types of academic positions—full- and part-time adjunct faculty, lecturer, research and teaching associate, administrator, postdoctorate—grew at a more rapid rate than the number of full-time faculty, increasing from 14,700 in 1973 to 46,200 in 1995. The 1989-95 increase was 25 percent, in contrast to the essentially flat full-time faculty count. Most of the growth in this segment was due to postdoctorate³¹ and other full-time appointments; part-time employees accounted for between 2 and 3 percent of the total throughout. (See appendix table 5-23.)

Employment growth was not uniform across different segments of higher education. Universities categorized as research universities in the Carnegie classification system experienced

³¹For more information on this subject, see "Postdoctoral Appointments" in chapters 2 and 3.

slower growth than other institutions;³² their doctoral S&E staff increased by 56 percent, from 57,600 in 1973 to 90,100 in 1995. Other universities and colleges combined had twice that rate of increase, as their numbers went from 60,400 in 1973 to 127,400 in 1995. Consequently, the proportion of academic doctoral scientists and engineers employed by research universities dropped from 49 to 41 percent during the period. (See text table 5-6.)

Women in the Academic Doctoral S&E Workforce³³

The number of academically employed women with S&E doctorates rose more than fourfold between 1973 and 1995, increasing from about 10,700 to an estimated 52,400. In comparison, the number of men increased by roughly 54 percent over the period, from 107,300 to 165,100. Consequently, men's employment share dropped by 15 percentage points, from 91 percent in 1973 to 76 percent in 1995. Women's gains were especially pronounced in psychology and the life and social sciences, fields where their participation in 1973 had already been the highest. (See appendix table 5-24.)

The recent decline in the full-time faculty component, dis-

Text table 5-6.

Academic doctoral scientists and engineers, by type of employing institution

_	e	Thousands employed by	Percentage employed by:		
	Academia (total)	Research universities	All other institutions	Research universities	All other institutions
1973	118.0	57.6	60.4	49	51
1975	134.1	63.3	70.8	47	53
1977	145.5	67.7	77.8	47	53
1979	155.4	71.3	84.1	46	54
1981	167.1	78.5	88.6	47	53
1983	176.2	77.2	99.1	44	56
1985	190.3	85.5	104.8	45	55
1987	196.0	91.3	104.7	47	53
1989	206.7	93.8	112.9	45	55
1991	210.6	93.5	117.1	44	56
1993	213.8	92.8	120.9	43	57
1995	217.5	90.1	127.4	41	59

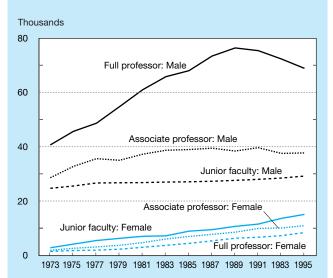
NOTE: Institution types are based on the Carnegie Foundation for the Advancement of Teaching classification of higher education institutions.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations. Science & Engineering Indicators – 1998 cussed above, was driven by an estimated 10 percent drop in the number of male full professors since 1989—from 76,300 to 68,800—combined with roughly stable numbers of male associate professors and junior faculty (assistant professors and instructors). (See figure 5-11.) But the number of women serving as full professors, associate professors, and junior faculty—assistant professors and instructors—increased by 30 percent or more during this time. By 1995, women constituted 21 percent of full-time S&E faculty. The number of women also increased faster than the number of men—41 versus 17 percent since 1989—in the other types of academic positions: full- and part-time adjunct faculty, lecturer, research and teaching associate, administrative, and postdoctorate. (See appendix table 5-24.)

Throughout the period, the field distribution of women remained more concentrated than that of men. Fully 84 percent of women scientists and engineers in 1995 were found in three broad fields: life sciences (41 percent), social sciences (21 percent), and psychology (22 percent). In contrast, only 58 percent of men were in these fields in 1995. Conversely, only 8 percent of women, but 19 percent of men, were in the physical and environmental sciences; and just 3 percent of women were in engineering versus 14 percent of men. (See appendix table 5-24.)

These field distributions in academic employment reflect the different field patterns of doctorate degrees earned by men and women. Over the past two decades, increased hiring of women into academia has been commensurate with women's rising proportion of new S&E doctorates. Among

Figure 5-11. Full-time doctoral S&E faculty, by rank and sex



NOTE: Faculty positions include full, associate, and assistant professors plus instructors. Junior faculty members are either assistant professors or instructors.

SOURCE: National Science Foundation, Survey of Doctorate Recipients, unpublished tabulations.

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³²This periodically revised classification describes research universities as institutions with a full range of baccalaureate programs, commitment to graduate education through the doctorate, annual award of at least 50 doctoral degrees, and receipt of federal support of at least \$15.5 million (average of 1989 to 1991). See Carnegie Foundation for the Advancement of Teaching (1994).

³³ Also see chapter 3, "Women in the S&E Workforce."

recent Ph.D.s in academic employment,³⁴ women have been represented in rough proportion to their share of newly awarded doctorates in every major field over the entire 1973-95 period. However, their proportion of the doctoral academic S&E workforce—24 percent in 1995—continues to lag their percentage of new S&E doctorates—38 percent. (See text table 5-7.)

Underrepresented Minorities in the Academic Doctoral S&E Workforce³⁵

Academic employment of underrepresented minorities—blacks, Hispanics, Native Americans, and Alaskan Natives³⁶—rose to 12,800 in 1995 from 2,400 in 1973. Their employment share rose from 2 percent in 1973 to 6 percent in 1995, the same as their share of full-time faculty positions. Relative gains for underrepresented minorities were greatest in psychology and the social sciences—where their employment share rose from 2 to 8 percent—and in engineering—from 2 to 5 percent. (See appendix table 5-25.)

These low but rising numbers reflect the growing number of S&E Ph.D.s earned by members of underrepresented

minorities.³⁷ For the past two decades, underrepresented minorities have been hired into academic positions at somewhat higher rates than would be expected based on their share of new S&E Ph.D.s awarded. As a consequence, their representation in the total academic workforce has been close to their share of new doctorates. (See text table 5-7.)

The distribution of underrepresented minorities by field is similar to that of whites, with two exceptions. Underrepresented minorities are *less* likely than whites to be in the life sciences—28 versus 34 percent, and they are *more* likely to be in psychology and the social sciences—41 versus 33 percent.

Asians in the Academic Doctoral S&E Workforce³⁸

Asians as a group have been quite successful in entering the academic workforce. The number of Asian academic doctoral scientists and engineers rose rapidly between 1973 and 1995, increasing from 5,100 to 22,500 in 1995. This growth more than doubled their employment share: 10 percent in 1995 versus 4 percent in 1973. Asians made especially strong gains in the physical sciences (from 5 percent in 1973 to 14 percent in 1995), computer sciences (from 13 percent in 1985 to 29 percent in 1995),³⁹ and engineering

Text table 5-7. Women, underrepresented minorities, and Asians in academic doctoral S&E employment

	Recent	Wom	en as a percentage	e of:		rrepresented mind s a percentage of:		Asians as a percentage of:		
i	academic S&E Ph.D.s ^a (thousands)	New S&E doctorates	Recent academic S&E Ph.D.s ^a	Total academic workforce	New S&E doctorates	Recent academic S&E Ph.D.s	Total academic workforce	New S&E doctorates	Recent academic S&E Ph.D.s ^a	Total academic workforce
1973	25.0	12	12	9	2	2	2	7	5	4
1975	23.4	16	17	10	3	4	2	6	7	5
1977	22.5	19	19	11	4	5	3	5	8	5
1979	20.9	22	21	12	5	5	3	6	8	6
1981	20.7	25	25	14	5	5	4	6	8	7
1983	20.5	28	28	15	5	5	4	5	10	7
1985	21.8	31	29	16	5	5	4	6	11	7
1987	21.1	32	29	17	6	6	4	6	12	8
1989	23.3	34	31	19	6	7	4	6	14	8
1991	25.5	36	35	20	6	7	5	7	16	8
1993	25.1	37	33	22	7	7	5	8	21	10
1995	26.9	38	38	24	7	7	6	15	23	10

^aRecent academic S&E Ph.D.s are defined as those in academic positions at the time of survey who have earned their S&E degree in the preceding three years.

SOURCES: National Science Foundation, Science Resources Studies Division, Survey of Earned Doctorates and Survey of Doctorate Recipients, unpublished tabulations.

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³⁴Recent Ph.D.s are those who have earned their doctorates within the past three years.

³⁵Also see chapter 3, "Racial/Ethnic Minorities in the S&E Workforce."

³⁶There is variation among and within these groups, which are treated here in the aggregate. Appendix table 5-25 provides somewhat more detailed data; the survey sample does not permit further disaggregation. Asians as a group have been quite successful in entering the academic workforce and are treated separately.

³⁷This in turn, of course, reflects their increasing participation in higher education and graduate school training. See chapter 2, "Master's Degrees by Race/Ethnicity" and "Doctoral Degrees by Race/Ethnicity."

³⁸Again, also see chapter 3, "Racial/Ethnic Minorities in the S&E Workforce."

³⁹Pre-1985 estimates are unreliable because of the low number of computer science degree-holders in the sample.

^bUnderrepresented minorities in S&E include black, Hispanic, Native American, and Alaskan Native respondents.

(from 9 percent in 1973 to 21 percent in 1995). (See appendix table 5-25.)

Asians are increasingly prominent among new Ph.D.s in academia, well in excess of their share of S&E Ph.D.s awarded to U.S. citizens and permanent visa-holders. That is, Asians, more than any other group, tend toward academic employment. By 1995, Asians accounted for nearly one-quarter of all new academic S&E doctorates. (See text table 5-7.)

Fifty-four percent of Asian academic S&E doctorates are in the physical, environmental, and computer sciences; mathematics; or engineering—a much higher proportion than for whites (33 percent) or underrepresented minorities (32 percent). Few Asians enter psychology, and a relatively small proportion is in the social sciences. (See appendix table 5-25.)

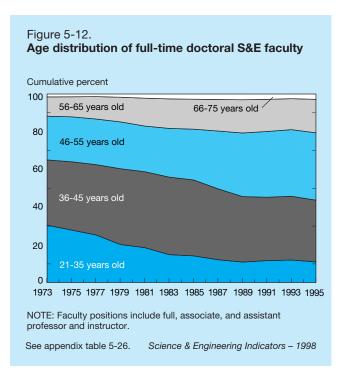
Employment Growth by Field

Academic employment in the physical sciences grew more slowly than in other fields over the 1973-95 period, rising from 22,100 to 29,300—33 percent growth compared to 84 percent for all of S&E combined. As a result, the share of academic doctoral scientists and engineers employed in the physical sciences fell from 19 to 13 percent; this drop was experienced in both physics and chemistry. In contrast, employment in the life sciences increased by more than 100 percent over the period, rising from 34,900 to 71,600; this field's employment share rose from 30 to 33 percent. Other fields experiencing relative gains were engineering and psychology. (See appendix tables 5-24 and 5-25.)

The Shifting Faculty Age Structure

The rapid pace of hiring of young Ph.D.s into academic faculty positions during the 1960s to accommodate soaring enrollments, combined with slower hiring in later years, resulted in an aging professoriate. (See figure 5-12.) Through the 1980s, a growing proportion of academic faculty was found in the older age brackets. A noteworthy feature of the data involves the upper end of these age distributions. The fraction of total faculty older than 65 has been about 3 percent for the past decade, with 1 percent older than 68 years. By and large, academics tend to retire before that age.

Concerns had been voiced early in the decade about the possible deleterious effects of delayed faculty retirements resulting from the full applicability of provisions of the Age Discrimination in Employment Act to universities and colleges starting in 1994. 40 The concerns focused on the potential ramifications for universities' organizational vitality, institutional flexibility, and financial health. A study by the National Research Council (NRC) concludes that "overall, only a small number of the nation's tenured faculty will continue working in their current positions past age 70" (NRC)



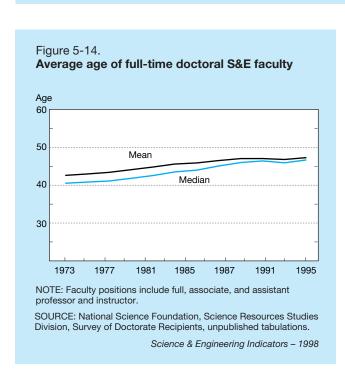
1991, p. 29), but adds: "At some research universities a high proportion of faculty would choose to remain employed past age 70 if allowed to do so" (NRC 1991, p. 38).

Recent data indicate, however, that, for the system as a whole, little has changed in the last decade in terms of retirement behavior. (See appendix table 5-27.) Across all of higher education, about 3 percent of full-time faculty stay on beyond age 65. As anticipated by the NRC study, faculty at research universities tend to keep working longer than those elsewhere. But it is also worth noting that research universities have managed to maintain a relatively more balanced age structure than other types of universities and colleges. (See appendix table 5-27.) The faculty age distribution in research universities tended to be older, on average, than that of other academic institutions through the early 1980s, but that tendency has since reversed. By 1995, research universities had a greater share of their full-time faculty in the under-46 age brackets than other institutions, and a slightly greater share in the above-60 ones as well. (See figure 5-13.)

The mean and median ages of full-time doctoral faculty show a clear upward trend from 1973 through 1989, with a flattening thereafter. (See figure 5-14.) This result can now be interpreted in light of the overall number of faculty, which grew through 1989 and has since essentially held steady in the range of 169,800 and 173,100. During the years of growth, the average faculty age climbed from 42.5 to 47.1 years before leveling off. This suggests that for academia as a whole—not necessarily for individual institutions or departments—a rough balance has been maintained between attrition from all causes and new hires. However, the number of replacements from 1989 onward has to be seen in the context of Ph.D. awards which rose by more than one-fifth overall from 1989 to 1995 (up from 22,705 to 27,846) and by 30 percent for U.S.

⁴⁰A 1986 amendment to the Age Discrimination in Employment Act of 1967 prohibited mandatory retirement on the basis of age for almost all workers. Higher education institutions were granted an exemption through 1993, allowing termination of employees with unlimited tenure who had reached age 70.

Figure 5-13. Age distribution of full-time doctoral S&E faculty at research universities and other academic institutions Percent in age bracket 100 Research universities All other universities and colleges 40 1973 1985 1995 20 ≤ 30 < 30 56-60 36-40 46-50 36-40 46-0 56-60 66+ 66+ ≤ 30 36-40 46-50 56-60 66+ 31-35 41-45 51-55 61-65 31-35 41-45 51-55 61-65 31-35 41-45 51-55 61-65 NOTES: Faculty positions include full, associate, and assistant professor and instructor. Research universities are defined by 1994 Carnegie categories. See appendix table 5-27. Science & Engineering Indicators - 1998



citizens and permanent residents. (This latter growth reflects in part Chinese students' conversion to permanent visa status following the Tiannanmen Square events.) In short, the modest increases in hiring from the late 1980s onward took place against a backdrop of steeply rising numbers of new Ph.D.s.

New Ph.D.s in Academic Employment⁴¹

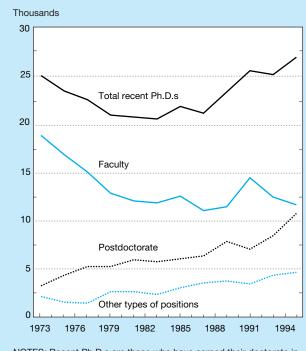
The presence in academic employment of people with newly earned S&E doctorates provides a leading-edge indicator of the future composition of the academic teaching and research workforce. Because of the small number of new Ph.D. recipients entering academic employment relative to the size of the existing workforce, changes in the overall composition of the academic workforce will occur slowly—but are already visible, as noted above.

The number of recent Ph.D.s entering into academia—defined as those who had earned their doctorate in the three years preceding the survey—declined gradually from 25,000 in 1973 through the early 1980s, reaching a low of 20,500. It then rose again through the mid-1990s, reaching 26,900 in 1995. These represent just over half of all recent doctorate-holders. (See appendix table 5-28.) But the meaning of academic "employment" has changed for these young Ph.D.s. Fewer than 45 percent had regular faculty appointments in 1995, compared with over 75 percent in the early 1970s and 57 percent in the mid-1980s. (See figure 5-15.) Since 1973, the proportion of new doctorate recipients holding postdoctorate positions has increased steeply, rising from 13 to 28 percent in 1985 and 40

⁴¹No trend data exist on detailed in- and outflows. The data reported here are "snapshots" of the number and demographic characteristics of doctorate-holders in academic employment who had earned their degree in the three years preceding the survey.

Figure 5-15.

Number of recent Ph.D.s in academic S&E, by type of position



NOTES: Recent Ph.D.s are those who have earned their doctorate in the preceding three years. Faculty positions include full, associate, and assistant professor and instructor.

See appendix tables 5-29 and 5-30.

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percent in 1995.⁴² The proportion of doctorates in other nonfaculty appointments has also doubled, rising from 8 to 17 percent. (See appendix table 5-30.)

The *demographic composition* of these recent academic doctorate-holders has shifted noticeably over two decades. The proportion of women has risen from 12 to 38 percent. The proportion of underrepresented minorities has grown from 2 to 7 percent, and of Asians from 5 to 23 percent. (See text table 5-7 and appendix table 5-30.) The *field composition* of young Ph.D.s reflects the larger employment changes: 38 percent are in the life sciences (up from 28 percent in 1973), 14 percent are in the physical sciences (after dropping from 16 in 1973 to 11 percent in 1985), and 4 percent are in mathematics (down from 9 percent in 1973). But the field distribution of young Ph.D. recipients in full-time faculty positions differs

from this total employment picture, with smaller faculty shares in the physical and life sciences and higher fractions in psychology and the social sciences. (See appendix table 5-29.)

Research and Teaching Activities⁴³

In the academic workplace, particularly in universities with a strong research orientation, teaching, research, and research training are often inextricably intertwined. In this way, academic research produces both new knowledge and highly trained personnel. Most academic scientists and engineers do not do either teaching or research, but pursue both activities in a mix that may change with the time of year and the course of their careers. Nevertheless, for the past two decades, a reasonably consistent indicator of the relative balance between teaching and research may be obtained from responses of academic doctoral scientists and engineers to a question about their major work responsibilities. The discussion here commences with an examination of a snapshot of the distribution of research and teaching activities, including undergraduate and graduate teaching, in academia; proceeds to trends in respondents' primary work responsibility; and closes by focusing on trends in primary and secondary responsibilities.

While not directly addressing the synergy between teaching and research, a survey (NSOPF) conducted by the U.S. Department of Education allows examination of the patterns of undergraduate and graduate teaching activities of doctoral academic scientists and engineers, and the extent of their research activities in relation to these teaching duties.

Of the estimated 213,800 doctoral scientists and engineers employed in academic institutions in 1993, 81 percent had some teaching duties in the fall semester of that year: 58 percent taught courses primarily for undergraduates, 25 percent taught courses primarily for graduate students, and 17 percent taught both graduate and undergraduate courses. (See text table 5-8.)

Those who taught undergraduate courses exclusively on average spent an estimated 65 percent of their weekly work time on teaching activities and 22 percent on research. For those with only graduate teaching responsibilities, the corresponding time estimates were 34 and 38 percent, respectively; and for those teaching both undergraduate and graduate

⁴² An accurate count of postdoctorates is elusive, and the reported increase may be understated. A postdoctoral appointment is defined here as a temporary position awarded primarily for gaining additional training in research. The actual use of the term, however, varies among disciplines and sectors of employment. In academia, some universities appoint postdoctorates to junior faculty positions which carry fringe benefits; in others, the appointment may be as a research associate. Some postdoctorates thus may not regard themselves as genuinely "employed." Also see "Postdoctoral Appointments" in chapters 2 and 3.

⁴³This material is based on individual respondents' reports of their primary and secondary work responsibilities. The data series—which is drawn from SDR-is reasonably consistent for the 1973-89 period: respondents were asked to designate primary and secondary work responsibilities from a list of items, the majority of which remained unchanged. Since 1991, however, primary and secondary work responsibilities have had to be inferred from reports of the activities on which respondents spent the most and second-most amount of their average weekly work time. These two methods yield close—but not identical—results, so the SDR series must be considered a rough indicator only. In addition, some nonrespondents in 1981-87 were sent a shortened version of the questionnaire that did not ask about secondary work responsibility. For these respondents and these years, secondary work responsibility was estimated using full-form responses, based on field and type of position held. This analysis also draws on data from the 1988 and 1993 NSOPF. As noted in "Data Sources: Nature, Problems, and Comparability," the sample estimates of numbers of faculty from this survey differ slightly from those derived from SDR.

Text table 5-8.

Teaching and research activities of academic doctoral scientists and engineers

			Average percenta	Average percentage of time spent on			
Surveyed doctoral scientists & engineers	Thousands	Percentage	Teaching	Research			
1988 survey							
Total with teaching responsibilities ^a	176.1	100	50	27			
Teaching undergraduates only	88.3	50	58	20			
Teaching graduate students only	57.1	32	35	38			
Teaching both		17	52	25			
1993 survey							
Total with teaching responsibilities ^a	173.4	100	50	25			
Teaching undergraduates only	100.0	58	65	22			
Teaching graduate students only		25	34	38			
Teaching both		17	50	27			

NOTE: Total is based on all survey respondents with a doctorate in a science or engineering field.

SOURCE: U.S. Department of Education, National Survey of Postsecondary Faculty, 1988 and 1993; unpublished tabulations by the National Science Foundation.

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students, the percentages were 50 and 27. These time estimates have not changed greatly since 1988.⁴⁴

Primary Work Responsibility: Emphasis on Research

SDR respondents (see "Data Sources: Nature, Problems, and Comparability") were asked to select their primary work responsibility from a list that includes teaching, various R&D functions, administrative work, consulting, and other activities. A crude but consistent indicator of the relative emphasis on research can be constructed from the responses. The choices in research activities as primary work responsibility reveal two major shifts. First, the relative balance between teaching and research has shifted toward the latter. Second, by this measure, growth of the research function has been especially pronounced outside the ranks of the traditional research universities.

The number of those reporting *teaching* as their primary work responsibility rose from 73,300 in 1973 to 101,100 in 1985 and has fluctuated around the 100,000 mark since then. In contrast, the number of those identifying *research* as their primary work responsibility has increased steadily, rising from 27,800 in 1973 to 56,000 in 1985 and 83,000 by 1995. These divergent trends have lowered the proportion of those reporting teaching as their primary work from 62 percent in 1973 to 46 percent in 1995, while the proportion of those reporting research as their primary work has risen from 24 to 38 percent. Those with other types of primary work responsibility—for administrative or managerial functions, service activities, and the like—constituted between 14 and 19 percent of the total over the period. (See appendix table 5-31.)

Employment growth in research universities since the late 1970s has been largely confined to those identifying research as their primary activity. Their number stood at 17,500 in 1973 and 45,900 in 1995, as their share rose from 30 to 51 percent of research universities' doctoral S&E workforce. In contrast, the number of research university faculty for whom teaching was the primary activity rose from 32,300 in 1973 to a high of 39,600 in 1981 before declining to 30,500 in 1995. The number identifying other functions as their primary work responsibility has remained at around 12,000 to 15,000 since the early 1980s. In other types of universities and colleges, a growing number of faculty identified teaching as their primary work activity for much of the two decades; since 1989, this number has fluctuated between roughly 67,000 and 70,000. But those for whom research was the primary work responsibility increased more rapidly and continuously. As their numbers grew from 10,300 in 1973 to 37,100 in 1995, their share rose from 17 to 29 percent. (See appendix table 5-31.)

Besides these institutional differences, there have been field differences as well. (See text table 5-9.) Employment growth from 1973 to 1995 has exceeded 50 percent in most fields, 45 except mathematics (41 percent) and—notably—the physical sciences (17 percent). Growth in *teaching* (as characterized here) was slower than overall employment growth in every field but the computer sciences; the physical sciences, by this measure, actually experienced negative growth. On the other hand, the number of respondents who designated *research* as their primary work responsibility

^aData include all respondents who indicated that the number of students they taught was greater than zero.

⁴⁴Those without fall 1988 teaching responsibility were ruled out of scope in that survey year, but not in 1993. The comparison with 1988 is based only on those 1993 respondents with teaching responsibilities.

⁴⁵Computer science data were not broken out before 1979. The series starts from a very low base and involves a relatively small number of respondents. Thus, the percentage increases in computer science teaching versus research growth must be viewed in this context and are best interpreted only within the field.

Text table 5-9.

Percentage change in the number of academic doctoral scientists and engineers by reported primary work responsibility, by field: 1973-95

		Percentage change in faculty (from 1973-95):						
Field	Total	Reporting teaching as primary	Reporting research as primary	Reporting other work as primary				
Total science and engineering	66	32	186	91				
Sciences	64	30	175	97				
Physical sciences	17	–12	128	76				
Environmental sciences	56	26	213	54				
Mathematics	41	25	89	137				
Computer sciences ^a	328	437	221	267				
Life sciences	79	26	165	113				
Psychology	85	49	237	108				
Social sciences	72	53	235	62				
Engineering	78	42	314	49				

NOTE: Primary work responsibility is defined by respondent's designation from 1973 through 1989; after 1989, primary work responsibility is defined by respondent's designation of activity consuming the most work time.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations.

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quadrupled in engineering and more than tripled in several science fields. In mathematics and the physical sciences, it roughly doubled.

Participation in Research

Academic work generally entails a more complex mix of functions—teaching, research, administrative work, consulting, public service, among others—than the above-discussed indicator (research as primary work activity) takes into account. A more encompassing measure can be constructed from respondents' choice of research as *either* a primary or secondary work function; this yields a better lower bound estimate of the broadly defined academic doctoral research workforce. He by this measure, an estimated 153,500 academic doctoral scientists and engineers were engaged in R&D in 1995, up from a range of 80,000 to 90,000 during the 1970s. The number of academic researchers has essentially been stable since the late 1980s, after strong growth in the preceding decade and a half. (See appendix table 5-32.)

Roughly 71 percent of all academic doctoral scientists and engineers reporting primary and secondary work re-

Figure 5-16. Academic doctoral scientists and engineers and those with research responsibility Thousands 250 200 All academic doctoral scientists and engineer 150 All with research responsibility 100 50 0 1973 1977 1981 1985 1989 1993 NOTES: Research responsibility is reported as primary or secondary responsibility for R&D. The numbers for 1981-85 are extrapolated, since not all respondents were asked about their secondary work responsibility in those years. See appendix table 5-32. Science & Engineering Indicators – 1998

sponsibilities in 1995 were engaged in research activities, but this varied by field. At the high end—80 percent—were the environmental sciences; the life and computer sciences and engineering ranged from 75 to 78 percent. Those in the physical sciences, mathematics, psychology, and the social sciences reported the lowest levels of research activity, ranging from 62 to 70 percent.

^aThe very large percentage increases in this field are based on a very small number of degree-holders in 1981.

⁴⁶The estimate fails to account for respondents who ranked research third or lower in their ordering of work responsibilities. Additionally, for 1981 through 1985, some respondents who received short forms of the survey questionnaire could not record a secondary work responsibility, thus resulting in a definite undercount for these years. All estimates are calculated based on individuals who provided valid responses to this item.

⁴⁷A rough estimate of the nondoctoral researcher component, excluding graduate research assistants, was derived for 1993 from NSOPF. This study suggests that this component is approximately 10 percent the size of the doctoral research workforce and is concentrated in the medical and health sciences (60 percent), biological sciences (15 percent), and engineering (10 percent).

These field differences in the levels of research intensity have been fairly consistent over time, and the field composition of academic researchers has generally not shifted dramatically. But the relative employment shift noted earlier away from the physical sciences and toward the life sciences is evident in the research workforce as well. The physical science share has declined by 6 percentage points since 1973, and that of the life sciences has increased by 3 percentage points, with marginal gains or losses for the other fields. (See appendix table 5-32.)

Federal Support of Academic Researchers

In 1995, 39 percent of the academic doctoral scientists and engineers responding to SDR reported receiving funding from the Federal Government during the week of April 15. (See text table 5-10.) This number cannot be easily compared with those from earlier years, which were based on a year-long reference period—49 percent in 1989, 50 percent in 1991—but is in line with SDR estimates for other reference periods shorter than a full year: 37 percent each in 1985 and 1993. If the volume of academic research activity is not uniform over the entire academic year, but varies to accommodate teaching and other activities, a one-week or onemonth reference period may well understate the extent of support over an entire academic year. Several pieces of evidence suggest this to be the case.⁴⁸

Just over half (51 percent) of the doctoral scientists and engineers surveyed in the 1993 NSOPF reported having Federal Government funding in the fall semester of that year. This is in line with earlier SDR estimates based on year-long reference periods. The NSOPF estimate, when taken together with information regarding growth in federal funding, suggests that no major changes have occurred since the late 1980s in the number or proportion of researchers supported with federal funds. This tentative conclusion is further bolstered by the steady growth in the number of federally funded research assistants through the 1980s and 1990s.

Notable and persistent field differences exist in the proportion of researchers supported by federal funds. 49 Above the overall S&E average are the life, environmental, and physical sciences and engineering. Clearly below the mean are mathematics, psychology, and the social sciences. The relative position of these fields has not changed substantially over the past two decades. (See text table 5-10.)

Since the late 1980s, a larger fraction of academic researchers has reported federal support from more than one agency. This trend can be observed across most S&E fields. (See appendix table 5-33.) Fields with the highest levels of researchers receiving multi-agency support are the environmental sciences—more than 40 percent—and engineering and the computer and physical sciences—well above 30 percent for each. Single-agency support is most prominent in the life and social sciences, psychology, and mathematics. However, no clear upward trend in multi-agency support is evident since the late 1980s.

Text table 5-10. Percentage of academic doctoral scientists and engineers reporting federal R&D support, by field

Field	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
Total science and engineering	46	42	41	39	42	44	37	48	49	50	37	39
Sciences	45	41	40	38	41	43	36	47	48	49	36	38
Physical sciences	49	45	46	44	50	51	43	54	58	56	46	48
Environmental sciences	47	46	43	45	49	54	51	60	63	65	51	54
Mathematics	29	19	19	21	21	30	21	31	33	34	19	22
Computer sciences	NA	NA	NA	35	30	45	45	62	52	49	40	43
Life sciences	60	59	57	55	59	59	53	65	65	65	52	52
Psychology	39	36	33	32	32	30	25	31	35	35	26	27
Social sciences	26	24	23	20	21	24	17	27	28	28	14	16
Engineering	55	50	51	49	50	55	42	57	56	63	43	50

NA = not available

NOTES: Data are based on respondents who answered "yes" or "no" to a question on whether they received federal support. Data for 1985 (italicized), which specified a reference period of one month, and for 1993 and 1995 (also italicized), which specified a one-week reference period, are not comparable to data from other years. Due to the nature of academic research funding, percentages in these years will tend to understate the proportion with federal support during an entire academic year.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations.

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⁴⁸Indirect evidence that the extent of support is understated can be gleaned from the number of senior scientists and postdoctorates supported on NSF grants. This number is published annually as part of NSF's budget submission. It bears a relatively stable relationship to numbers derived from SDR in 1987, 1989, and 1991, but diverges sharply in 1993. (The figures from the two data sources are never identical, however, since NSF's numbers reflect those funded in a given fiscal year, while SDR numbers reflect those who have support from NSF regardless of when awarded.)

⁴⁹The relative field shares of federally supported researchers appear to be stable across recent survey years, i.e., they are relatively unaffected by changes in the survey reference period. The distribution (but not the estimated number) based on NSF estimates is quite similar.

The interpretation of these data is ambiguous. They could, for example, indicate greater difficulty in obtaining funding, the growing availability of multiple funding sources, or increasing entrepreneurism by investigators in seeking out funding.

Integration of Research With Graduate Education

Science and engineering graduate students have a fairly unique role as both an input to and an output of the U.S. academic research system. U.S. research universities have traditionally coupled advanced education with research, both generating new knowledge and producing advanced scientific and engineering talent. This integration of research and advanced training in S&E is encouraged because the system has served the country well. U.S. research universities attract graduate students from across the nation and around the world. Upon receipt of their advanced degrees, these students set out to work in many sectors of the U.S. economy, using the skills and knowledge they have acquired to meet a broad range of challenges.

It is difficult to determine the exact number of S&E graduate students who are participating directly in the research process at their universities in a given year. Obviously, those students who are supported primarily through research assistantships are participating in research. Many of the students who are supported with other modes of support such as traineeships and fellowships are also likely to be directly involved in research activities at their institutions. And even students who are self-supported or are on teaching assistantships may be involved in research, at least part of the time. Any student who is working on a doctoral dissertation is expected to be doing research; in many cases, those working on master's theses are also expected to be doing research.

This section examines the sources and mechanisms of support for full-time S&E graduate students. Since the number of students supported by a research assistantship in any year is probably a lower bound for the number of S&E graduate students participating in research activities at U.S. universities, special emphasis is given to the role of the research assistantship. For a more in-depth treatment of graduate education, see chapter 2.

Support of S&E Graduate Students⁵⁰

Trends in Support

In 1995, for the first time in almost two decades, enrollment of full-time S&E graduate students declined slightly. A 12-year trend of steady increases in enrollment of full-

time graduate students whose primary source of support was the Federal Government also ended, as did an even longer upward trend in the number of graduate students whose primary source of support was from nonfederal sources. 51 The number of self-supported graduate students—that is, those whose largest source of support comes from loans or from personal or family financial contributions—also declined for the first time since 1988. (See appendix table 5-34.) It is too early to tell whether the 1995 enrollment decline is the beginning of a trend or simply a one-time drop. Preliminary evidence indicates, however, that this is not a one-time phenomenon, but rather part of a longer decline. For example, first-time enrollments of full-time S&E graduate students declined in both 1994 and 1995, and preliminary estimates from the 1996 Graduate Student Survey indicate that overall full-time enrollment dropped again in 1996.

Since 1980, there have been significant shifts in the relative usage of different types of primary support mechanisms. (See figure 5-17.) These shifts have been due more to rapid growth in some support mechanisms than to an absolute decline in the number of students supported by any of these mechanisms. In the past several years, concern has been voiced in a number of places about the value of different modes of support for S&E graduate students and whether the Federal Government and other providers of financial assistance should consider shifting the mix of their support (COSEPUP 1995 and NSF 1996d). For a summary of these discussions, see "Concern About Forms of Support for S&E Graduate Students."

The proportion of graduate students with research assistantships as their primary support mechanism increased from 22 to 27 percent between 1980 and 1995. This increase was offset by a drop in the proportions of students supported by traineeships (from 7 to 5 percent) or by teaching assistantships (from 23 to 20 percent). Most of these changes had occurred by the late 1980s, with proportional shares being relatively stable during the first half of the 1990s.

These overall shifts in support mechanisms between 1980 and 1995 occurred for both students supported primarily by federal sources and for those supported by nonfederal sources (this excludes students whose primary source of support is

⁵⁰All the data presented on mechanisms and sources of support for S&E graduate students in this and subsequent sections of this chapter are from the NSF-NIH annual fall survey of Graduate Students and Postdoctorates in Science and Engineering, unless otherwise indicated. In this survey, departments report the primary (largest) source and mechanism of support for each full-time degree-seeking S&E graduate student. No financial support data are collected for part-time students. Many of the full-time students may be seeking master's degrees rather than Ph.D. degrees, particularly

in fields such as engineering and the computer sciences. Sources of support include federal agency support (from NIH, other HHS entities, NSF, DOD, or USDA); nonfederal support; and self-support. Support mechanisms include fellowships, traineeships, research assistantships, teaching assistantships, and other. Note that despite this section's emphasis on primary source and primary mechanism of support, most graduate students are supported by more than one source and one mechanism during their time in graduate school, and that individual graduate students often receive support from several different sources and mechanisms in any given academic year. Throughout this section, S&E includes the health fields (medical sciences and other life sciences).

⁵¹Total federal support of graduate students is underestimated since reporting on federal sources includes only direct federal support to a student and support to research assistants financed through the direct costs of federal research grants. This omits students supported by departments through the indirect costs portion of research grants; such support would appear as institutional (nonfederal) support, since the university has discretion over how to use these funds.

Figure 5-17. Support for full-time S&E graduate students Percent 100 Self-support 30 Teaching assistantships Research assistantships 20 Fellowships Other mechanisms **Traineeships** 1980 1982 1984 1986 1988 1990 1992 NOTE: S&E includes the health fields (medical sciences and other life sciences) See appendix table 5-34. Science & Engineering Indicators - 1998

self-support). Among students whose primary source of support was the Federal Government:

- the proportion of those whose primary mechanism of support was a research assistantship increased from 55 to 66 percent,
- ♦ the proportion whose primary mechanism was a traineeship decreased from 25 to 15 percent, and
- those with fellowships as their primary support mechanism fluctuated between 8 and 12 percent of the total over this period.

The Federal Government has an almost negligible role in supporting teaching assistantships.

Among students whose primary source was nonfederal:

- ♦ research assistantships rose from 20 to 29 percent,
- ♦ teaching assistantships fell from 48 to 42 percent,
- ♦ fellowships fluctuated between 13 and 14 percent, and
- ◆ traineeships ranged between 3 and 4 percent of the total.

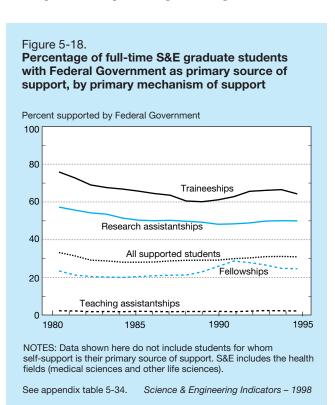
Patterns of Support by Institution Type

The proportion of full-time S&E graduate students with primary support from various sources and mechanisms differs for private and public universities. (See appendix table 5-35.) A larger proportion of full-time graduate students relies primarily on self-support in private academic institutions as opposed to those in public institutions—39 versus 30 percent in 1995.

Nonfederal sources are the primary source of support for a larger proportion of students in public institutions (50 percent) than in private ones (41 percent). For both private and public institutions, about 20 percent of students receive their primary support from the Federal Government.

A larger proportion of students attending public academic institutions relies on research assistantships and teaching assistantships as their primary support mechanism (30 percent and 23 percent, respectively) than those attending private institutions (21 percent and 13 percent, respectively). This is balanced by greater reliance on fellowships and traineeships in private institutions (14 percent and 8 percent, respectively) than in public ones (7 percent and 4 percent, respectively).

The Federal Government plays a larger role as the primary source of support for some mechanisms than for others. (See figure 5-18.) A majority of traineeships in both private and public institutions (53 percent and 73 percent, respectively) is financed primarily by the Federal Government, as are 60 percent of the research assistantships in private institutions and 47 percent in public institutions. The Federal Government provides the primary support for less than 30 percent of fellowships and less than 2 percent of teaching assistantships in both public and private institutions.



Concern About Forms of Support for S&E Graduate Students

Although there is general agreement that students in S&E disciplines who obtain Ph.D.s from U.S. research-oriented universities are among the best prepared and most successful scientists and engineers in the world, some believe that the challenges of educating scientists, mathematicians, and engineers for the 21st century mandate a new paradigm in graduate training. They contend that doctoral programs could better prepare students for careers outside of academe or basic research by ensuring that they are versatile rather than narrowly specialized and that they are equipped with skills, such as interpersonal communication and the ability to work well in teams, that will enhance their ability to succeed in the real world.

The Committee on Science, Engineering, and Public Policy of the National Academy of Sciences in a report released in 1995, *Reshaping the Graduate Education of Scientists and Engineers*, focuses on Ph.D.s and discusses the changing context of graduate education and the employment trends and prospects for the employment of graduate scientists and engineers. One of the report's major recommendations is: "to foster versatility, government and other agents of financial assistance for graduate students should adjust their support mechanisms to include new education/training grants to institutions and departments." The authors feel that research assistantships, although they offer educational benefits in the form of research skills, focus doctoral programs on the needs of research projects rather than on the broader educational needs of the students.

In June 1995, the Mathematical and Physical Sciences Directorate (MPS) of the National Science Foundation planned and hosted a conference on education and employment patterns of graduates in the mathematical and physical sciences. Conference participants endorsed the following recommendations: (1) mechanisms should be found to encourage a broadening of the training and education experience of MPS graduate students; (2) mechanisms should be examined for shortening the average time to Ph.D. degree in MPS fields; (3) the use of off-campus experience, such as industrial internships, should be increased; and (4) efforts should be made to decrease gradually the proportion of graduate students funded as research assistants and to increase gradually the proportion funded by other mechanisms, including traineeships and fellowships, as well as novel, collective modes of support (NSF 1996d).

The National Science Board Task Force on Graduate Education was established in June 1995 to examine the merits and mix of the several modes of funding support (e.g., research assistantships, fellowships, traineeships) used by NSF to support graduate and postdoctoral education, and the impact of the various modes of support on the experience and preparation of those supported. The members concluded that sufficient data linking both the national data and NSF support data did not exist to make

recommendations for major revisions in the mix of NSF funding. Their report (NSB 1996)—delivered in February 1996—did, however, endorse: (1) limited studies on alternative modes of graduate support with defined goals and assessment criteria; and (2) data collection and/or research on funding mechanisms and various aspects of graduate student education and employment.

As part of the call for changes in the manner in which S&E graduate students are supported, the merits of various support mechanisms have been discussed and a number of hypotheses developed about the advantages and disadvantages of different mechanisms. In fact, some of the characteristics of a specific mechanism that are cited as disadvantages by some individuals are cited as advantages by others. For instance, the portability of fellowships and the independence they give to graduate students are seen by some as a distinct advantage because they provide these students with a lot of freedom to pursue a wide variety of interests. Others argue that students with fellowships are more likely than those being supported by traineeships or research assistantships to become isolated from their peers and from the faculty in their departments, and thus may either be less likely to complete their Ph.D. or to take longer to do so. Some argue that although having a fellowship at the beginning of a graduate career may be detrimental, having one when working on a dissertation is highly advantageous.

Similarly, some argue that since research assistantships are directed to the needs of funded research projects, doctoral students can become so involved on a specific project that they have little time for independent exploration or other educational activities, thus limiting the areas in which they acquire experience. A counterargument is that the skills and experience students acquire by focusing on a specific research project are indispensable to the high-quality, state-of-the-art research being conducted at U.S. universities and industrial laboratories. Some argue that strong reliance on research assistantships can bias research and graduate training toward those areas that have long track records rather than to new and exciting areas and that they also may prevent beginning faculty from attracting graduate students. Others argue that it is the widespread availability of research grants that provides young faculty with the opportunity to work closely with graduate students.

Unfortunately, it is extremely difficult to examine many of these hypotheses analytically either because of the absence of data or the inability to capture the hypothesized outcomes quantitatively. In addition, most graduate students depend on multiple sources and mechanisms of support while they are in graduate school, and frequently on different sources and mechanisms of support in different phases of graduate work. This makes it quite difficult, if not impossible in many cases, to identify a one-to-one relationship between a student and a support source or mechanism.

Support Patterns for All S&E Graduate Students Versus Doctoral Recipients⁵²

Most S&E graduate students do not go on to receive a Ph.D. It is thus useful to compare the support patterns of those students who do earn a Ph.D. with the patterns for all fulltime S&E graduate students to see if they differ significantly. Twenty-nine percent of the students receiving Ph.D.s in science and engineering in 1995 reported that their primary mechanism of support during their time in graduate school was a research assistantship. This is close to the percentage (27 percent) of full-time S&E students for whom a research assistantship was reported as the primary mechanism of support. Fellowships and teaching assistantships were reported less frequently as a primary mechanism of support by those students who earned an S&E Ph.D. (2 percent and 6 percent, respectively) than for all full-time S&E graduate students (9 percent and 20 percent, respectively). Traineeships, however, were reported more frequently by those receiving an S&E Ph.D. (13 percent) than for graduate students in general (5 percent). A considerably smaller percentage of students receiving an S&E Ph.D. reported self-support as their primary means of support (18 percent) than did graduate students in general (32 percent). (See appendix tables 5-36 and 5-37.)

Anecdotal evidence suggests that students are more likely to be teaching assistants in the early stages of graduate school when they are doing their coursework than in the later stages when they are working on a doctoral dissertation. Therefore, if students receiving Ph.D.s are more likely to report those mechanisms that supported them in the later years of graduate school as primary, it might explain the small percentage reporting teaching assistantships as a primary support mechanism.

Research Assistantships as a Primary Mechanism of Support

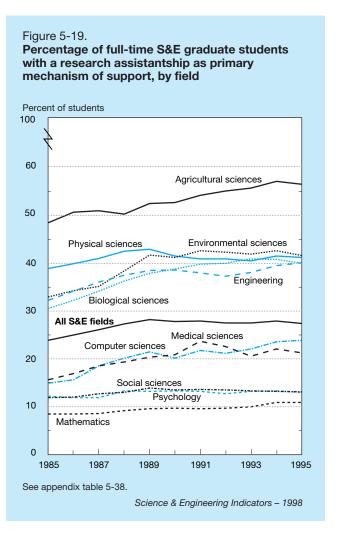
Graduate RAs by S&E Field

As indicated previously, research assistantships account for 27 percent of all support mechanisms in 1995. However, the mix of support mechanisms—and thus the role of RAs as the primary support mechanism—differs by S&E field. (See appendix table 5-37.) RAs comprise more than 50 percent of the primary support mechanisms for graduate students in astronomy, atmospheric sciences, oceanography, agricultural sciences, chemical engineering, and materials engineering. They account for less than 20 percent in the social sciences, mathematics, and psychology.

The overall number of graduate students with an RA as their primary mechanism of support increased every year between 1985 and 1994 before declining slightly in 1995. (See appendix table 5-38.) Most S&E fields exhibited similar trends, although not all showed a decline in 1995. In just about every S&E field, the percentage of graduate students with an RA as their primary means of support was higher in 1995 than in 1985. The largest increases were in the atmospheric sciences (13 percent), electrical/electronic engineering (12 percent), civil engineering (10 percent), computer sciences, earth sciences, biological sciences, and industrial engineering (all 9 percent). (See figure 5-19.)

All S&E Graduate Students Versus Doctoral Recipients

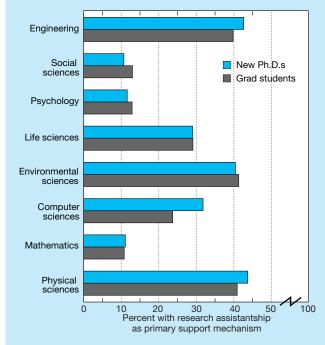
The relative utilization of an RA as a primary mechanism of support was also fairly consistent at a broad disciplinary level between the Ph.D. and graduate student surveys. (See figure 5-20.) Research assistantships were once again quite prominent in the physical sciences, environmental sciences, and engineering; and were of much less prominence in mathematics, the social sciences, and psychology, confirming the earlier results.



⁵²Another source of data on sources and mechanisms of financial support of S&E graduate students is the annual Survey of Earned Doctorates. Students who have just received their Ph.D.s are asked to respond to this survey. One survey question asks them to identify their primary and secondary sources of support during graduate school as well as to check all other sources from which support was received. Validation studies on the quality of the data received from respondents to this survey indicate that the information on mechanisms of support is much better than that on sources. This is especially true for students whose primary support is a research assistantship since they may not always know who is providing the funds that are supporting them. For this reason, the comparison between the graduate student survey and the doctorate survey is confined to mechanisms of support except for self-supported students.

Figure 5-20.

Relative importance of research assistantships as primary mechanism of support for full-time S&E graduate students and new S&E Ph.D.s, by field: 1995



NOTE: Life sciences includes the health fields (medical sciences and other life sciences).

See appendix tables 5-36 and 5-37.

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Sources of Support

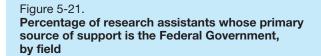
In 1995, about one-third of graduate research assistants were in the life sciences, with an additional 30 percent in engineering and 13 percent in the physical sciences. The Federal Government was the primary source of support for about half of all graduate students with an RA as their primary mechanism of support. (See appendix table 5-39.) The Federal Government was the primary source of support for significantly more than half of the research assistants in the physical sciences (75 percent), the environmental sciences (63 percent), and the computer sciences (62 percent); and for considerably less than half in the social sciences (20 percent) and psychology (32 percent). The proportion of graduate research assistants for whom the Federal Government was the primary source of support declined from 58 percent in 1975 to about 50 percent in 1985, where it has remained pretty much through 1995. Similar trends held for the environmental sciences, psychology, social sciences, medical sciences, and engineering. The physical sciences were more variable; chemistry and physics had declining federal shares in both 10-year periods, but astronomy showed little change in the first decade and a considerable decline in the second. The federal share of research assistants in the computer sciences declined from 61 to 49 percent between 1975 and 1986 and then proceeded to increase once again to 62 percent by 1995. (See appendix table 5-40 and figure 5-21.)

Federal Agency Support⁵³

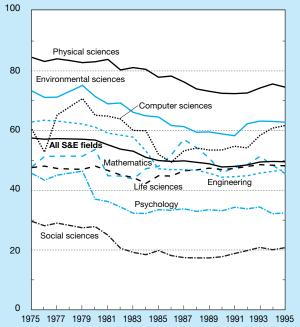
From the early 1970s to the late 1980s, NSF was the federal agency that was the primary source for the largest number of graduate RAs. It was surpassed by HHS (as a whole) in 1989 and by NIH in 1993. Between 1972 and 1995, the percentage of federal graduate RAs financed primarily by NSF declined from one-third to less than one-quarter, while the percentage financed primarily by NIH increased from one-sixth to one-quarter. The DOD share has fluctuated between 10 and 16 percent over the period. (See appendix table 5-41.)

Just as federal agencies emphasize different S&E fields in their funding of academic research, they also emphasize

⁵³Only four federal agencies are reported on individually as primary sources of support to S&E graduate students in the Survey of Graduate Students and Postdoctorates in Science and Engineering: DOD, NSF, USDA, and HHS; the latter is reported as two distinct units—NIH and other HHS. NASA has been added to the 1996 survey.



Percent supported primarily by the Federal Government



NOTES: Research assistants are students for whom a research assistantship is reported as their primary mechanism of support. Life sciences includes the health fields (medical sciences and other life sciences).

See appendix table 5-40.

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different fields in their support of graduate research assistants. HHS and especially NIH concentrate support in the life sciences (53 and 72 percent, respectively); as does USDA (72 percent). DOD concentrates its support in engineering (55 percent). NSF, on the other hand, has a more diversified support pattern, with one-third in engineering, 30 percent in the physical sciences, and 12 percent in the environmental sciences. (See figure 5-22 and appendix table 5-42.)

Although an agency may place a large share of its support for research assistants in one field, it may not necessarily be an important contributor to that field overall, particularly if it is a small agency in terms of its support for graduate research assistants. (See figure 5-23 and appendix table 5-43.) NSF is the lead supporting agency in mathematics (44 percent of federally supported RAs), the environmental sciences (42 percent), the physical sciences (37 percent), and engineering (29 percent). NIH is the lead support agency in the life sciences (58 percent), psychology (54 percent), and sociology (31 percent). DOD is the lead support agency in the computer sciences (43 percent) and—of those agencies included in the survey—in aeronautical/astronautical engineering (38 percent), electrical/electronic engineering (41 percent), and mechanical engineering (29 percent). USDA is the lead support agency in the agricultural sciences (61 percent) and economics (58 percent).

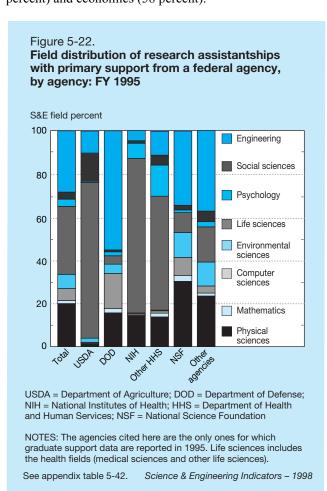


Figure 5-23. Research assistantships supported primarily by the Federal Government, agency shares by S&E field: FY 1995 Percent 100 Other Health and Human Services 80 National Science Foundation 60 Other agencies National 40 Institutes of Health Department of Defense 20 Department of Agriculture Journal and Property of the Committee of Computer sciences Life sciences Social sciences **Pakrylogy** Engineering NOTE: Life sciences includes the health fields (medical sciences and other life sciences). See appendix table 5-43. Science & Engineering Indicators - 1998

The Spreading Institutional Base

Between 1979 and 1995, there was a slight increase in the number of universities and colleges reporting at least one RA as a primary mechanism of support for their S&E graduate students (385 to 415), with the number reaching its highest level (435) in 1993. Not surprisingly, however, there was basically no change in the number of research universities or doctorate-granting institutions reporting the presence of graduate RAs during this period; this number fluctuated between 219 and 224. Since these institutions had probably been receiving research funds over the entire period, it is likely that they were supporting graduate students with research assistantships. Thus, most of the fluctuation and the entire increase in the number of institutions reporting graduate RAs occurred among comprehensive; liberal arts; two-year community, junior, and technical; and professional and other specialized schools. (See text table 5-11.)

The data suggest that most of the increase in the number of institutions reporting RAs as a mechanism of support for their S&E graduate students is due to increasing support from nonfederal sources—probably from the institutions themselves—rather than from the Federal Government.

In addition, throughout this period, considerably fewer institutions reported students with RAs financed primarily by the Federal Government than with assistantships financed primarily from nonfederal sources. This difference is par-

Text table 5-11.

Number of academic institutions reporting graduate research assistantships, by primary source of support and type of institution

Primary source	Number of institutions reporting research assistantships																
of support and institution type ^a	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
All sources of support																	
All institutions Research and	385	400	425	408	413	332	324	318	320	412	415	425	413	426	435	421	415
doctorate-granting Other	220 165	222 178	223 202	224 184	224 189	221 111	217 107	214 104	215 105	224 188	221 194	222 203	222 191	219 207	222 213	219 202	220 195
Nonfederal sources of support All institutions	352	371	403	383	390	321	310	307	306	396	399	404	394	410	418	404	404
Research and doctorate-granting Other	211 141	217 154	218 185	218 165	216 174	218 103	214 96	213 94	214 92	221 175	221 178	221 183	221 173	218 192	221 197	216 188	219 185
Federal sources of support																	
All institutions Research and	297	297	316	308	296	269	261	254	266	292	299	302	303	305	312	312	303
doctorate-granting Other	207 90	207 90	213 103	210 98	209 87	210 59	204 57	197 57	200 66	209 83	205 94	203 99	205 98	206 99	206 106	209 103	205 98

NOTES: Numbers in italics (1984 to 1987) are not comparable with earlier or later years because only a sample of master's-granting institutions rather than the entire population was included in the survey during these years.

^aThese are the institutional categories used by the Carnegie Foundation for the Advancement of Teaching. See chapter 2, "Characteristics of U.S. Higher Education Institutions," for information on these categories. "Other" institutions are all Carnegie-classified institutions except research and doctorate-qranting institutions.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science Engineering, various years, unpublished tabulations.

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ticularly pronounced among the "other" Carnegie institutions, 98 of which report RAs supported by the Federal Government in 1995 compared to 185 that report RAs financed by nonfederal sources. Why so many fewer other institutions report the Federal Government as a primary source of funds for research assistantships than receive R&D funds from the Federal Government is unclear.

Outputs of Scientific and Engineering Research

The products of academic research, as noted elsewhere in this chapter, include trained personnel and advances in knowledge. The former have been discussed in chapter 3 of this volume and in the preceding sections of this chapter. This section deals with indicators of advances in knowledge—specifically:

- 1. The published outputs of natural science and engineering research in a set of refereed journals, discussed in terms of:
 - ◆ the output volume of research—by country and field and, in the case of the United States, by sector—using article counts as the indicator;
 - ◆ patterns of research collaboration—across national and, for the United States, sectoral boundaries—using multi-author articles as the indicator;
 - ♦ the use of research outputs in subsequent scientific and engineering research—again, international and intersectoral—using citation counts as the indicator; and
 - the potential practical utility of these research outputs, as indicated by citations to these articles on U.S. patents.
- 2. Patents issued to U.S. universities and colleges—i.e., the number and types of patents, institutions with patent awards, and revenue generated by patents and licenses.

Article Outputs

This discussion of article outputs places the United States in the context of other countries contributing to the world scientific literature and examines that literature by field.⁵⁴ For a description of the data used in this analysis and its limitations, see "Data Sources for Article Outputs."

U.S. Articles

In the United States, increased attention has been given to cross-sectoral collaboration in scientific and engineering research. Of particular interest has been the collaboration between industry and universities to enrich the research perspectives of investigators in both settings and to create a means for more efficiently channeling research results toward practical applications. This section discusses the sectoral distribution of U.S. articles, patterns of cross-sectoral collaboration and citation, and multidisciplinary connections of these articles.

Sectoral Distribution. About 142,800 scientific and technical articles were published by U.S. authors in 1995 in the set of 4,800 journals. Of these:

- ◆ 71 percent were academic publications;
- ◆ 8 percent each were produced by industry and the nonprofit sector (mainly health-related organizations publishing in the biomedical fields—i.e., biology, clinical medicine, and biomedical research); and
- ♦ 8 percent were produced by the Federal Government, with an additional 3 percent published by FFRDCs—these latter were mainly in the physical sciences and engineering.

These proportions represent a slightly enhanced position for academic publications since 1981 (68 percent) and an off-setting decline in the federal share including FFRDCs. (See appendix table 5-44.)

The number of *academic papers* increased in all fields but biology (down 25 percent since 1981) and mathematics (down 27 percent). The decrease in biology was partially offset by a strong increase in biomedical research articles, possibly reflecting a shift in focus. No ready explanation is evident for the decline in mathematics outputs. (See appendix table 5-45 for field taxonomy.)

Industry publishing has undergone considerable change over the period, reflecting both growing interest in the biomedical fields and a decline in some more traditional areas of industry activity. Industry publications almost doubled in clinical medicine and tripled in biomedical research; these two fields combined accounted for 4,700 industry articles—or 39 percent of this sector's total in 1995, versus 19 percent in 1981. Industry publications in physics, chemistry, and engineering and technology—fields traditionally emphasized in industrial research—as well as mathematics all declined in absolute numbers during the 1990s; engineering and technology suffered a particularly steep decline during the 1980s. The precise reasons for these declines are unclear, but they may in part reflect one outcome of the restructuring and refocusing of corporate R&D activities.⁵⁵ (See appendix table 5-44.)

Article production by the Federal Government fell and was steady overall for FFRDCs. Federal research output in biomedicine and chemistry was steady. Physics and earth and space sciences articles were up; but a declining output in clinical medicine, biology, mathematics, and engineering and technology outweighed these numerical increases. In the case of FFRDCs, increased publications in physics and earth and space sciences balanced declines in other fields. Nonprofit organizations increased publication in the biomedical fields, in which they have a combined 11 percent share. (See appendix table 5-44.)

Cross-Sectoral Collaboration. Scientific and engineering research in the United States increasingly involves investigators from several employment sectors, as evidenced by the steady increases in the number and proportion of articles with authors from more than one sector. This increase is evident for all sectors and for all fields—even those with declining output—except mathematics, where the modal pattern remains sole authorship.

Just under one-quarter (24 percent) of all academic papers published in 1995 involved collaboration with one or more authors from other sectors—6 percent from industry, 8 percent each from the Federal Government and not-for-profit sectors, 3 percent from FFRDCs, and 2 percent from other sectors. ⁵⁶ While this proportion may appear low, it involved roughly 25,900 articles and represented an increase from 20 percent in 1981 (20,100 articles). (See appendix table 5-46.)

The propensity of scientists and engineers employed in other sectors to collaborate across sectoral boundaries was much higher than for their academic colleagues—50 percent in industry, 56 percent in FFRDCs, and 60 percent and above in the other sectors. Moreover, 1981-95 increases in cross-sectoral collaboration have been more pronounced in the nonacademic sectors, ranging from 7 percentage points for nonprofit institutions to 23 percentage points for industry. But most of the cross-sectoral collaborations involved one or more academic authors.

Intersectoral Citation Patterns. Research builds upon previous results, and references to scientific and technical articles reflect their utility in subsequent work. The distribution of such citations to U.S. scientific and technical articles largely—

⁵⁴This section discusses *all* article outputs produced, regardless of originating sector. Not all of these articles originated in the academic sector. However, 71 percent of them did in 1995, and many others involve collaboration with academic researchers or heavily cite the academic literature. Moreover, the non-U.S. literature cannot be cleanly broken out by performing sector.

⁵⁵These declines apparently do not reflect a lack of coverage of newly established journals in the Institute of Scientific Information data set. They were checked against trends in the 1985 and 1991 ISI journal sets, and, while the absolute numbers varied across sets, the direction and relative rates of change for these industry fields were found to be very similar.

⁵⁶These details add up to more than 24 percent because of the incidence of papers involving authors in three or more sectors.

Data Sources for Article Outputs

The article *counts* discussed in this section are based on scientific and engineering articles published in a stable set of about 4,800 journals selected by the Institute of Scientific Information (ISI) as the base for its Science Citation Index in 1981. Fields covered are clinical medicine, biomedical research, biology, physics, chemistry, earth and space sciences, mathematics, and engineering and technology. Appendix table 5-45 lists the constituent fine fields. A database covering the social sciences and behavioral aspects of psychology is being prepared for inclusion in future *Indicators* volumes. The database *excludes* letters to the editor, news pieces, editorials, and other content whose central purpose is not the presentation or discussion of scientific data, theory, methods, apparatus, or experiments.

ISI periodically updates its journal coverage, based in part on references to articles in publications not currently included in the database. Given this citations-based updating, ISI's database appears to give reasonably good coverage of a core set of scientific journals (albeit with some English-language bias), but not necessarily of all that may be of regional or local importance. This last point may be particularly salient for the engineering and technology category and for nations with a small or applied science base. In this discussion, *long-term publishing trends* in-

cluding coauthorship patterns are based on a journal set established by ISI in 1981. *Citation trends* are based on a 1985 journal set. Of course, new journals are always being created, and old ones cease publication. No attempt has been made here to trace the birth and death of journals and their selection for coverage by SCI over the years. All data derive from the Indicators Bibliometrics database prepared for NSF by CHI Research, Inc.

Articles are attributed to sectors and countries by the authors' institutional affiliation, which introduces certain complexities and limitations. For example, a paper is considered to be multi-authored only if two or more authors have different institutional affiliations. The same rule applies to cross-sectoral or international collaborations. For example, a paper written by a U.S. citizen temporarily residing in the United Kingdom in collaboration with someone at his or her U.S. home institution is counted as internationally coauthored, thus possibly overstating the extent of such collaborations. On the other hand, a paper coauthored by a British citizen temporarily located at a U.S. university with another member of the faculty would not be considered internationally coauthored, thus understating the count.

but not entirely—reflects the distribution of the articles themselves, with the bulk of citations going to academic papers. The academic sector contributes 71 percent of all articles and receives 71 percent of all citations. Its citation frequency in clinical medicine, biomedical research, and mathematics is slightly below its publications share; in biology, chemistry, and engineering and technology, the citation frequency exceeds its publications share. (See appendix table 5-47.)

Industry articles are cited at a higher frequency than their share would suggest in the fields of physics and engineering and technology. In recent years, however, both of these fields have experienced a decline in the number of industry articles as well as a decline in the number of citations to these articles.

Linkages Among Disciplines. Research on many scientific challenges increasingly relies on the knowledge and perspectives of a multitude of disciplines and specialties. Biologists seeking to understand cell functions supplement techniques and approaches developed internally with others developed in engineering, chemistry, and physics. Citations in scientific and technical articles that cross disciplinary boundaries are one indicator of the multidisciplinary nature of the conduct of research. The citation patterns among Science Ci-

tation Index articles provide a glimpse of connections among major fields and fine fields.⁵⁷

Citations in 1994-95 U.S. articles contained in SCI were aggregated by field.⁵⁸ Of the roughly 2.3 million references, articles in the three life sciences—which accounted for 63 percent of the U.S. output—contained 73 percent of the citations, those in other sciences and mathematics 25 percent, and engineering and technology articles just over 2 percent. The distribution of these citations across major fields shows the expected high incidence of references to articles in the same broad field, ranging from 69 to 83 percent in the physical and earth and space sciences to 62 percent in biology. Articles in the combined life science fields cited other life science articles 98 percent of the time. However, the citation patterns are not symmetrical. A greater proportion of citations in the physical sciences, mathematics, and engineering and technology focuses on the life science fields than vice versa. (See appendix table 5-48.)

⁵⁷Data for other indicators of multidisciplinary research activities are not readily available: collaboration of researchers across disciplinary boundaries, multidisciplinary centers, and major multidisciplinary projects—e.g., global climate research—lack readily available representative data or a ready framework for their analysis.

⁵⁸Specifically, references in articles with one or more U.S. authors published in 1994-95 in journals covered by the 1985 SCI set that cited other U.S. articles published in 1990-93.

Examination of fine fields underscores the tight connections among the life science fields. Citations in clinical medicine and biomedical research articles are largely to other articles in these same major fields—90 percent or higher with most of the remaining citations to biology. This does not mean that their research is isolated from other major fields. About 6,200 citations in clinical medicine and 20,000 in biomedical research articles were to physical sciences, engineering, or mathematics journals. But these represented tiny portions of their total citations—numbering 920,000 and 651,000, respectively. Pharmacy and pharmacology, for example, cite articles in chemistry journals; some biomedical specialties cite chemistry, physics, earth and space sciences, and engineering and technology. The earth and space sciences' connection to biomedical research is intriguing: 4 percent of astronomy/astrophysics citations were to this literature, which in turn received more than 200 citations from general biomedical research articles. These citation links reflect, among other things, the well-publicized adaptation of astronomy imaging techniques to medical diagnosis uses. Otorhinolaryngology articles contain references to the acoustics literature—physics—reflecting a similar connection. (See appendix table 5-48.)

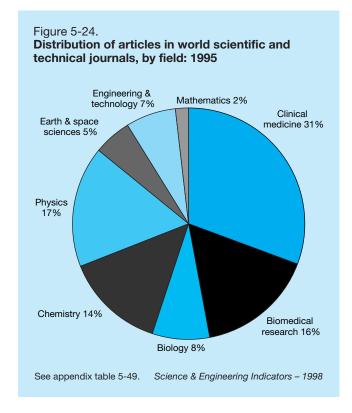
Trends in International Article Production

The article counts reported here indicate the volume of scientific publishing in a given field and country, and the field mixes of different countries, as reflected in this set of core journals. In interpreting these counts, note that they reflect field-to-field and country-to-country variations in publishing conventions and differing sizes of scientific infrastructures. The discussion focuses on broad trends and relationships. (See "Data Sources for Article Outputs.")

Worldwide publication of scientific and technical articles in the SCI journal set stood at about 439,000 in 1995. (See appendix table 5-49 for detailed counts.) Almost one-third of these—135,000—were articles in clinical medicine; biomedical research and biology accounted for an additional 107,000 articles. Articles in chemistry, physics, and the earth and space sciences numbered 61,000, 74,000, and 23,000, respectively; there were 31,000 articles published in engineering and technology, and 8,000 in mathematics. (See figure 5-24.)

Five nations produced more than 60 percent of all articles in the SCI set of journals in 1995: the United States (33 percent), Japan (9 percent), the United Kingdom (8 percent), Germany (7 percent), and France (5 percent). No other country's output reached 5 percent of the covered articles' total. The regional distribution of these articles is shown in figure 5-25.

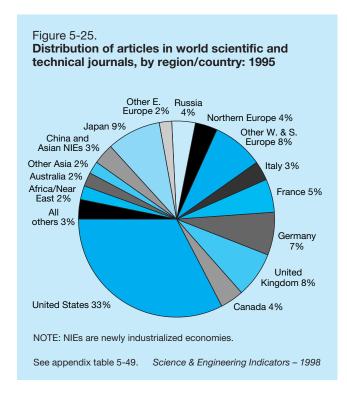
From 1981 to 1995, the number of articles published worldwide in the SCI journal set rose by almost 20 percent,



compared with 8 percent in the United States alone.⁵⁹ This increase coincided with the development or strengthening of national scientific capabilities in several world regions, a development that was particularly pronounced after the end of the Cold War. Thus, a gradual decline in the U.S. world share since the early 1980s continued through the mid-1990s, despite continued growth in U.S. publications output. (See appendix table 5-49.) The European share rose from 32 to 35 percent over the period. It is likely that these gains partially reflect European nations' concerted policies to strengthen the science base in both individual countries and across Europe as a whole.

The article volume of the Central European states—Bulgaria, Czech Republic, Hungary, Poland, Romania, and Slovakia—as a group declined through the early 1990s but rebounded to close to its 1981 level by 1995 (9,100 articles). In contrast, the article output for the nations of the former Soviet Union declined at an accelerating rate after the late 1980s, dropping from about 30,000 in 1981 to 22,000 in 1995; this decrease led to a decline in world share from 8 to 5 percent. This long-term decline in world share is not entirely attributable to the disintegration of the Soviet Bloc, although this certainly continues to contribute to the trend. Articles reflect work done one or more years earlier, and the decline has been gradual and observable over the entire period. It is likely that relative political and scientific isolation, combined with economic difficulties, has affected

⁵⁹These figures are minimum estimates. While figures from an expanded journal set selected in 1985 are higher, they show roughly the same rate of increase. Data from a journal set selected in 1991 suggest a steeper real rate of increase from 1991 to 1995.



the conduct of scientific research in this region.

Southeast Asia's emergence as a potent, high-tech region is well-known, 60 and data on article production present evidence of a robustly developing indigenous S&E base. The Asian nations' world share of publications rose from 11 to nearly 15 percent since 1981, but contradictory trends combined to produce this total. The number of articles produced by Japan increased from 25,100 in 1981 to 39,500 in 1995; this represents a 57 percent increase, three times the world average. Very large percentage increases over the period though from very low bases—were evident for China (from 1,100 to 6,200 articles) and the newly industrialized Asian economies: Taiwan (from 370 to 3,900), South Korea (170 to 3,000), Singapore (120 to 900), and Hong Kong (from 500 in 1987⁶¹ to 1,100 in 1995). While these gains were realized on a small output base and the combined output remains modest, the combined world share involved rose from onehalf of 1 percent to 3.4 percent in a very short time—with no decrease in growth vet evident. On the other hand, India's publications output has contracted by 33 percent since 1981, dropping from 11,700 articles to 7,900 in 1995.⁶²

Since the conduct of research reflected in these article outputs requires financial, physical, and human resources—in short, a scientific infrastructure—the potential for further shifts in article distributions can be gleaned from a brief comparison of the economic and article outputs of selected countries. While no simple relationship exists between the relative size of a nation's GDP and its article output volume,63 there do appear to be some general tendencies. (See appendix table 5-50.) For the nations shown, the number of papers produced per billion U.S. dollars of GDP ranges from 2 to 54. (See figure 5-26.) Israel and a number of smaller European nations rank highest, exceeding 30 articles per billion U.S. dollars of GDP. The United States is in the middle range, with 20 articles per billion dollars of GDP. Nations with fast-developing economies have smaller than expected article outputs. There is also a large number of nations with economies that are small, or small on a per capita basis, that contribute little to the world's scientific output.

Field Distribution of Articles

As noted earlier, for all countries combined, the life sciences accounted for the bulk (55 percent in 1995) of the articles in the SCI database. (See figure 5-24.) The nearly 20 percent increase in world articles from 1981 to 1995 was driven by increases in physics (63 percent), the earth and space sciences (36 percent), and biomedical research (30 percent). Biology and mathematics publications declined in number (by 11 and 23 percent, respectively), possibly signaling the demise of some journals in these fields. Chemistry and clinical medicine articles increased slightly (by 12 and 16 percent, respectively); while those on engineering and technology did not increase at all. Because of the large number of articles produced each year, shifts in field distribution have been small but noticeable. (See text table 5-12.) For example, the life science share fell by 2 percentage points; those of mathematics and engineering and technology fell by 1 point. Within the life sciences, biology's share fell by 3 points while biomedical research articles increased, suggesting a gradual shift in research focus. The share of physics articles increased by 5 percentage points over the period.

U.S. Article Output in the International Context

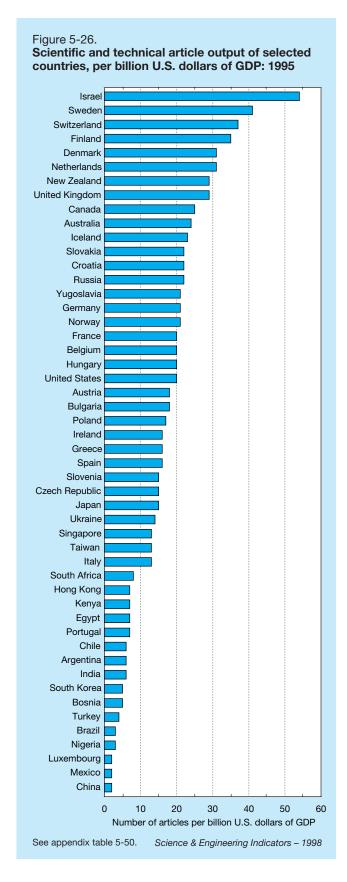
The roughly 142,800 U.S. articles published in 1995 accounted for about 33 percent of the world's total, up in number from 132,300 in 1981 but down from the almost 36 percent share of world total these articles then represented. This drop reflects the fact that other nations' publications output has expanded relatively faster than that of the United States. U.S. output has grown in some fields: notably—in round numbers—from about 22,000 to 28,000 in biomedical research, and from 13,000 to 18,000 in physics. It has

⁶⁰The emergence of these Asian countries in high-tech economic activity is described in NSF (1995a). The expansion of their education activities in science, engineering, and technology is described in NSF (1993a). See also discussions in chapter 2 on higher education developments and chapter 4 on patterns of R&D support.

⁶¹Hong Kong's data for years before 1987 were reported with the United Kingdom's.

⁶²See Raghuram and Madhavi (1996). The authors note that this decline cannot be attributed to journal coverage in SCI, and that it is paralleled by a decline in citations to Indian articles. They speculate that an aging scientific workforce may be implicated, along with a "brain drain" of young Indian scientists whose articles would be counted in the countries in which they are published, not in the author's country of origin.

 $^{^{63}} The$ simple correlation between GDP share and share of world articles produces an r^2 of 0.75. However, once the United States is removed, the r^2 drops precipitously to 0.29.



Text table 5-12.

Share of world scientific and technical articles, by field
(Percentages)

-			s Change,
Field	1981	1995	1981-95
Total life sciences	57.2	55.1	-2.1
Clinical medicine	31.5	30.7	-0.9
Biomedical research	15.0	16.4	1.4
Biology	10.6	8.0	-2.7
Total physical sciences	31.7	36.2	4.4
Chemistry	14.8	14.0	-0.8
Physics	12.3	16.9	4.6
Earth and space sciences	4.6	5.3	0.7
Engineering and technology	8.3	7.0	-1.4
Mathematics	2.8	1.8	-1.0

been roughly steady in clinical medicine, at about 50,000. Declines in output occurred in biology (from 15,000 to 11,000), engineering and technology (from 12,000 to 10,000), and mathematics (from 4,000 to 3,000). (See appendix table 5-49.)

See appendix table 5-51. Science & Engineering Indicators - 1998

But the U.S. article portfolio is quite different from that of other major producers (see "The Science and Technology Portfolios of Nations," below); consequently, U.S. world share, and changes in world share, are field dependent. The biggest relative declines occurred in engineering and technology (7 percentage points) and biology (6 points). Smaller declines in the U.S. share (2 to 4 percentage points) occurred in clinical medicine, the earth and space sciences, and mathematics. The physics share contracted by nearly 5 points, while chemistry held steady.

The Science and Technology Portfolios of Nations

Nations make implicit or explicit choices about the nature of their science and technology portfolios through their allocation of resources; the results of these choices are reflected, to some degree, in their article output data. (See appendix table 5-51.) It is clear that different nations have very different choice patterns, and that these patterns can—and do—change over time.⁶⁴

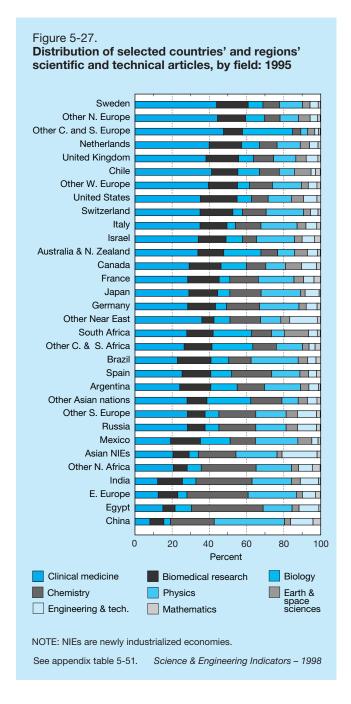
Figure 5-27 shows the 1995 portfolio mix of a range of countries, arrayed by the fraction of their total output devoted to clinical medicine and biomedical research (which account for about half of these articles worldwide). The differences in emphasis are striking. The United States, United Kingdom, countries of Northern Europe, several smaller Western European nations, and Chile all emphasize these fields quite heavily. At the other end of the spectrum are China and the rapidly growing newly industrialized Asian econo-

⁶⁴ See also the discussion in chapter 2, "Worldwide Increase in S&E Educational Capabilities," on the field distributions of S&E degrees of various nations.

mies, India, Eastern Europe, Egypt, and Mexico, each of which has a small fraction of its portfolio in these fields.

In contrast, France, Germany, Spain, Italy, Eastern European nations, Russia, Mexico, Japan, the newly industrialized Asian economies (especially), India, China, and Egypt put far more weight than the world average on chemistry and physics. Russia, China, Egypt, and—again especially—the Asian economies are noteworthy for their concurrent emphasis on engineering and technology.

Countries tend to shift the focus of their scientific activities gradually over time. (See appendix table 5-51.) Major shifts toward chemistry—and, to a lesser extent, physics—are evident for some of the world's developing nations and regions. Russia, which once had an extremely heavy stake in



these traditional fields, is shifting away from them. Biology research is in relative decline around much of the world, in favor of increases in the more applied life science disciplines. Engineering and technology has lost ground in many national portfolios relative to other fields. Note, however, that the portfolios of some of these countries were very small in 1981, making relatively large percentage changes possible as publication counts have grown.

International Scientific Collaboration

In many fields, cutting-edge science is increasingly dependent on knowledge, perspectives, and techniques that cross traditional disciplinary boundaries. Often, the scope of the problem (e.g., constructing a coordinated array of widely spaced telescopes or mapping global environmental trends), combined with complexity and cost, suggests or even dictates broad collaboration that increasingly involves international partners. Both trends—increased collaboration and growing international cooperation—can clearly be seen in the publications data. A pervasive trend toward greater scientific collaboration affects all article fields, and a steadily growing fraction of most nations' papers involves international coauthorship. This section examines these trends, the U.S. position in international collaboration, who collaborates with whom, how developing and developed nations compare, and what collaboration patterns exist for and among Asian nations. 65

Trends in Scientific Cooperation. A pronounced world-wide tendency exists toward greater scientific collaboration, as evidenced by patterns of corporate coauthorship of scientific and technical articles written by authors located in two or more different institutions. ⁶⁶ This phenomenon can be observed in every field, every sector, and most countries. Moreover, such collaboration is increasingly international, involving researchers from different nations. ⁶⁷ In 1995, the proportion of the world's papers that were coauthored (in this multi-institution sense) was 50 percent; almost 30 percent of these involved international collaboration. (See appendix table 5-52.) The number of coauthored articles increased from 121,000 in 1981 (33 percent of the total) to 219,400 in 1995

⁶⁵The data discussed in this section involve the incidence of article coauthorship in which the authors' institutional affiliations are located in two or more countries. These data have certain limitations. For example, a paper written by a U.S. citizen temporarily residing in the United Kingdom in collaboration with someone at his or her U.S. home institution is counted as internationally coauthored, thus possibly overstating the extent of such collaborations. On the other hand, a paper coauthored by a British citizen temporarily located at a U.S. university with another member of the faculty would not be considered internationally coauthored, thus understating the count. Further, the data suggest a growing trend toward multiple-country coauthorship. However, the trends discussed here are sufficiently broad-based and robust to give confidence in the measure.

⁶⁶This provides a lower bound estimate and understates the true number of papers with multiple authors. The database counts corporate coauthorships—that is, two or more authors are counted as coauthors only if they are at two or more institutions. The trends reported here are internally consistent.

⁶⁷Among the causes of these increases are no doubt the extent of advanced training students and recent doctorate-holders receive outside their native countries and the web of intergovernmental agreements inviting or requiring multinational participation in some research activities.

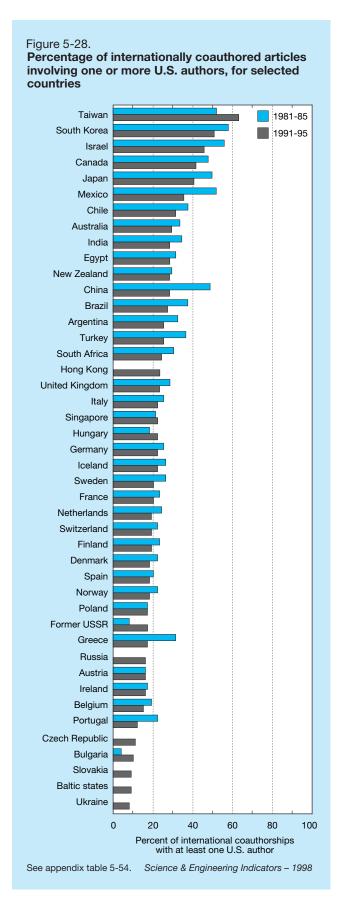
(50 percent). Over this period, the number of internationally coauthored articles worldwide increased by 200 percent—from 21,000 to 63,800—while the total number of articles rose by about one-fifth. This increase in turn caused a rise in the proportion of all papers published worldwide involving some degree of international coauthorship—from 6 percent in 1981 to 15 percent in 1995.

Corporate coauthorship varies by field. For example, in the 1991-95 period, the U.S. average of coauthored articles was 56 percent, but clinical medicine was well above that with 64 percent of its articles coauthored. Chemistry, engineering and technology, biology, and mathematics had lower rates of corporate collaboration, at 39, 43, 46, and 47 percent, respectively; the other fields were close to the mean. (See appendix table 5-53.) Wider variation exists in rates of international collaboration. Measured against all coauthored articles, the U.S. average was 29 percent for 1991-95, but this was heavily influenced by a 19 percent rate of clinical medicine articles. On the other hand, 51 percent of coauthored mathematics articles involved international collaboration, as did 46 percent of physics and 42 percent of earth and space sciences articles.

The position of the United States in international collaboration (as evidenced by coauthorship) is characterized by two complementary trends. For almost every nation with strong international coauthorship ties, the number of articles involving a U.S. author rose strongly between 1981 and 1995. During this period, however, many nations broadened the reach of their international collaborations, causing a gradual diminution of the U.S. share of the world's internationally coauthored articles. (See appendix table 5-54.)

The United States has one of the highest coauthorship rates in the world: 58 percent of U.S. articles published in the ISI journal set involved corporate coauthorship in 1995, up from 43 percent in 1981. U.S. authors contributed 42 percent of all coauthored articles and participated in 45 percent of all internationally coauthored articles—well in excess of the 33 percent U.S. article share. But of all U.S. articles published in 1995, only 18 percent involved international coauthors, a smaller percentage than that of most other nations. These numbers reflect the sheer size of the domestic U.S. science base. Worldwide, domestic and international coauthorships have also risen, often more steeply (in terms of the proportion of a country's papers involved) and to higher levels than in the United States. For most countries, the share of internationally coauthored articles ranges from 25 to 40 percent of their output; but Japan and India (15 percent each), Russia (21 percent), and other former Soviet countries (13 percent) are well below this range. (See appendix table 5-52.)

Who Collaborates With Whom? International scientific collaboration, as measured by the percentage of a country's multi-author articles involving international coauthorship, centers to a considerable degree on the United States. (See figure 5-28.) In the first half of the 1990s, about one in five internationally coauthored papers published in major European industrial nations involved collaboration with the United



States; for many other nations, the rate was much higher. For example, Japan and India, with low rates of international collaboration, shared 40 and 28 percent of their international coauthorships with the United States, respectively; China, 28 percent; Taiwan, 62 percent; and South Korea, 50 percent. (See appendix table 5-54.) Rates of collaboration with the United States ranged from 25 to 35 percent for major South and Central American countries, 45 percent for Israel, and near 30 percent for Australia and New Zealand. Countries of the former Soviet Union collaborated relatively less frequently with U.S. partners, as did all Central European nations except Hungary.

Examination of this same indicator for an earlier period— 1981-85—suggests that the scientific world is witnessing the development of new centers of activity, probably reflecting continuing political and economic developments in the wake of the end of the Cold War. Comparison of 1981-85 and 1991-95 data shows strong growth in the number of articles with authors from more than one nation, and—at the same time a broadening of international collaborative ties. (See appendix table 5-54.) While coauthorship with the United States continued to rise in terms of number of publications, it declined with many countries in terms of the share of all their internationally coauthored articles. (See figure 5-28.) The share drop (but not a decline in the number of articles) in collaboration with the United States was most striking for China—roughly 20 percentage points—but is evident for most other countries as well. A similar pattern, though much attenuated, is evident for the major European industrial nations.

In the Asian region, the trends are somewhat erratic, but generally indicate the development of regional cooperative patterns involving—especially—China and the newly industrialized economies. Regional collaboration, as measured by the proportion of coauthored articles with an author from another Asian country, is almost 25 percent for South Korea, in excess of 30 percent for Singapore and Hong Kong, and around 15 to 20 percent for most other countries; India and Japan have lower rates of coauthorship. The degree of collaboration with Japan has increased for some but not all of these nations, and the absolute number of papers with Japanese coauthors has risen. Collaboration with the United States is high for these economies: Taiwan, 62 percent; South Korea, 50 percent; Japan, 40 percent; China and India, 28 percent each; and the other Asian nations about one-fifth. Collaboration with Europe is less prominent, ranging from 10 to 25 percent for the entire continent.

The Central European states have fairly strong regional collaborative ties, given the relatively small volume of their collective publications output. They share 10 to 15 percent of their internationally coauthored articles. From roughly half to 60 percent of these articles are shared with the rest of Europe—most strongly with Germany (around 20 percent); and the United Kingdom, France, and Italy combined (15 to 20 percent). These figures have increased over their levels in the 1980s, as ties to the countries of the former USSR have generally attenuated in the 1990s. International collaboration involves U.S. scientists in about 10 percent of the cases in Czech

Republic, Slovakia, and Bulgaria; in excess of 15 percent for Poland; and over 20 percent for Hungary.

Russia's collaborative ties are mainly with the United States (roughly 15 percent); Germany (15 percent); and the United Kingdom, France, and Italy combined (20 percent). The rest of Europe represents 20 percent; collaboration with other former member states represents 10 percent. As a group, the countries of the former Soviet Union (except the Baltic states) have much the same pattern, though with weaker cooperative links to the United States and Germany, and stronger links to other European nations. Scientists in the Baltic states who collaborate internationally tend to do so with colleagues in the Scandinavian countries (25 percent), attesting to strong cultural and regional ties among these nations.

The U.S. pattern of international coauthorship stands in sharp contrast to those just described (as it must, given the high percentages of U.S. involvement in most other nations' international collaborations). No one country contributes more than 10 percent to the U.S. articles with multinational authors. Canada, the United Kingdom, Germany, all of Southern Europea, the Northern European countries, and all other Western European nations combined contribute between 7 and 10 percent each; the Eastern European and former Soviet states combined contribute another 7 percent; Japan and the other combined Asian nations contribute about 8 percent each. This is a much more even distribution of international collaborative ties than is seen for the other countries.

Countries with small indigenous science establishments tend to have higher levels of international coauthorship as a percentage of their total article output than do those with larger, more mature systems. Rather than collaborating regionally, scientists from developing nations tend to work with those from major science-producing nations. In the case of small but mature nations (e.g., the Northern or smaller Western European countries), this pattern is augmented by regional collaboration. Political isolation, economic disruption (as in the case of the states of the former Soviet Union), and cultural or language barriers (as in the case of Japan) can influence these patterns and result in unusually low degrees of international collaboration.

Use of Scientific and Technical Articles in Subsequent Research

The global dimensions of the conduct of scientific activity, discussed above in terms of international research collaboration, are also reflected in the patterns of citations to the literature. Scientists and engineers around the world cite prior work done elsewhere to a considerable extent, thus demonstrating the usefulness of this output in their own work. Citations to one's own country's work are generally prominent and show less of a time lag than citations to foreign outputs. Regional citation patterns are evident as well, but citations to research outputs from around the world are extensive.

U.S. scientific and technical articles are cited by virtually all mature scientific nations in excess of the U.S. output's world share. (See appendix table 5-55.) This broad finding needs to be qualified, however, since citation patterns and

practices vary by field. More specifically, the finding holds for chemistry, physics, biomedical research, and clinical medicine. U.S. articles in the remaining fields tend to be cited at or slightly below their world output share.

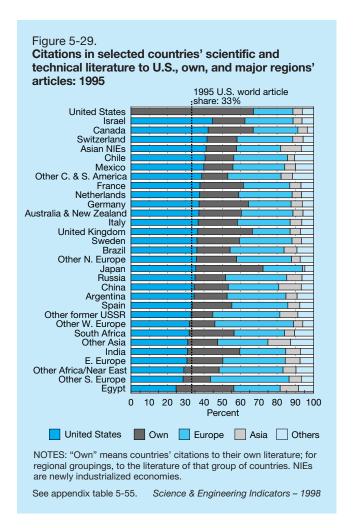
Not surprisingly, all countries cite their domestic literature well in excess of their respective world shares, but no other country cites its domestic literature as heavily as does the United States—67 percent. Another 14 percent of U.S. citations are to British, French, German, and Italian articles; 7 percent each to the articles of other European nations and Asia and the Pacific (4 percent for Japan); 68 and 3 percent to Canadian articles. 69 The high U.S. self-citation rate might conceivably reflect insularity, but the high proportion of involvement of U.S. scientists in internationally coauthored articles casts doubt on this interpretation.

A comparison of citations to the U.S. literature (the leftmost column of appendix table 5-55) with those to a nation's domestic output (diagonal values) shows a generally larger share of total citations to U.S. than to domestic articles. (See figure 5-29.) In part, of course, this reflects the scale and breadth of the U.S. scientific and technical establishment. Yet there is no compelling reason why one country's literature should be cited in proportion to its world output share by any other country. For example, no European country cites another European country's output at the rate of the cited country's article share, despite the many arrangements that foster collaboration and knowledge flows among the European nations. It appears reasonable to conclude that scientists elsewhere find the outputs from U.S. research quite useful in the conduct of their own work, as evidenced by the volume of references to the U.S. literature in other countries' scientific and technical articles.

The citations in articles from the four largest European industrial nations—the United Kingdom, France, Germany, and Italy—refer to their respective domestic outputs 21 to 30 percent of the time, to articles of the other countries in the set 11 to 18 percent of the time, and to U.S. articles between 36 and 38 percent of the time. Output from the rest of Europe receives 10 to 12 percent of citations; Canada, 3 percent; and Asia and the Pacific, 7 percent (4 to 5 percent to Japanese articles).

The citations from other Western, Southern, and Northern European nations refer to their own domestic literature 10 to 23 percent of the time—reflecting their generally smaller domestic science base—and the four large European industrial nations 18 to 28 percent. The United States receives 32 to 42 percent of the citations; and other European nations combined, 10 to 17 percent. Asia and the Pacific receive 7 to 9 percent of these nations' citations.

The pattern of citations among Central European nations is similar, with a regional component of 3 percent, and an additional 1 to 3 percent referring to the literature of the former Soviet states. A stronger orientation than for most other coun-



tries is evident toward Asia and the Pacific, which receive a combined 9 to 11 percent of the citations.

Somewhat less reliance on European science output, somewhat greater reliance on that of the United States, and more of a regional Asian/Pacific focus mark the citation ties of the Asian nations. China and the newly industrialized economies cite their own articles only 10 to 20 percent of the time, but cite each others' articles 12 to 16 percent of the time—high relative to the size of their science bases. Japan's pattern is different (37 percent self-citation and only 2 percent of citations to articles from other states in the region); as is India's (29 percent self-citation, 6 percent citation to Japan's output, and 2 percent to the rest of the region).

Patent Outputs

Governments assign property rights to inventors in the form of patents to foster inventive activity that may have important economic benefits. The U.S. Patent and Trademark Office grants such government-sanctioned property rights in the form of patents for inventions deemed to be new, useful, and non-obvious. This section discusses recent evidence about strength-

⁶⁸Asia and the Pacific includes Australia and New Zealand.

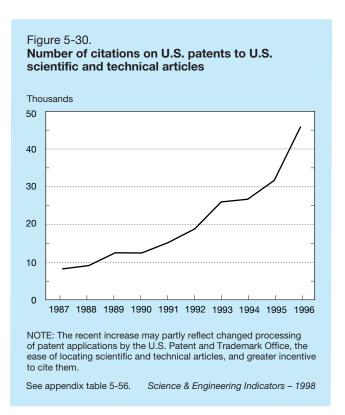
⁶⁹Percentages do not total 100 because of rounding.

ening ties between scientific and technical research and patenting activity, trends in academic patenting, and income from these activities flowing to universities and colleges.⁷⁰

Citations in U.S. Patents to the Scientific and Technical Literature

Patent applications cite "prior art," including scientific and technical articles, that contributes materially to the product or process to be patented and upon which it improves. These citations provide some indication of the potential contributions of published research results to patentable U.S. inventions. A number of caveats apply. The use of patenting varies by industry segment, and many citations on patent applications are to prior patents. Industrial patenting is only one way of seeking to ensure firms' ability to appropriate returns to innovation and thus reflects, in part, strategic and tactical decisions. Such patenting can be defensive or forward-looking, or can lay the groundwork for cross-licensing arrangements. Most patents do not cover specific marketable products but might conceivably contribute in some fashion to one or more such products in the future. These caveats notwithstanding, citations to the scientific and technical literature give one indication of the linkage between research outputs and innovative applications, as judged by the patent applicant.

The scientific and technical literature is increasingly likely to be cited on U.S. patents. The percentage of U.S. patents citing at least one scientific or technical article increased from 11 percent in 1985 to 14 percent in 1990 and 23 percent in 1995.⁷¹ To further explore this trend, citations to U.S. research articles included in the SCI set of journals were identified and classified by field and performer sector for all U.S. patents issued from 1987 through 1996. The number of such citations increased from 8,600 in 1987 to 47,000 in 1996⁷² (see figure 5-30 and text table 5-13), and their field distribution shifted dramatically toward the life sciences. The rise in the number of citations held for all fields and for papers from all sectors. (See appendix table 5-56.) The fastest growth, however, occurred in the life sciences. The biomedical research share rose from 28 to 44 percent, and that of clinical medicine rose from 26 to 29 percent. The combined share of physics, chemistry, and engineering and technology citations dropped from 43 to 24 percent of these patent citations—but not their absolute number, which rose from 4,018 in 1988 to 11,246 in 1995.



Citations to academic articles rose faster than to those from industry or government authors, pushing the academic share of the total from 49 to 55 percent. The increase was driven by strong gains in chemistry (where the academic share rose from 58 percent in 1988 to 65 percent in 1995), physics (from 29 to 40 percent), and engineering and technology (from 31 to 44 percent).

A recent study examined all citations on the front page of all 397,660 U.S. patents awarded in 1987-88 and 1993-94 (Narin, Hamilton, and Olivastro 1997). Many of these citations are to other patents, but among all citations, 430,226 referred to nonpatent materials; of these, 242,000 were judged to be science references, of which 175,000 were to materials in SCI journals. Among the study's findings are a rapid increase in the number of citations to scientific and technical articles on U.S. patent applications; a shortening of the time elapsed between publication and citation on patents; and a large proportion of such citations to publicly funded science (defined by the authors to include articles by academic, nonprofit, and government authors).73 References tended to be to articles appearing in nationally and internationally recognized, peer-reviewed journals, including journals publishing basic research results, and to be field- and technology-specific.⁷⁴ The authors note both national (U.S. patents citing U.S. authors with greater than expected frequency) and regional components in the patterns of citations.

⁷⁰Chapter 6 presents a more comprehensive discussion of patented inventions in all U.S. sectors.

⁷¹Personal communication with Francis Narin and Kim Stevens, CHI Research, Inc.

⁷²The U.S. Patent and Trademark Office changed its processing of patent applications during this period, and some of the observed increase probably reflects these changed practices and applicants' responses to them. Furthermore, greater ease of locating—electronically—the relevant prior art, and greater incentives to include all possible elements thereof, may also contribute to the increase. Nevertheless, the direction of the trends reported here is congruent with those in academic patenting, discussed below. The number of citations reported here refers to articles published in an 11-year span, as follows: 1987 patent citations are to articles published in 1973 to 1984, 1995 citations to those published in 1981 to 1992.

⁷³This latter finding is broadly consistent with results obtained by Mansfield (1991), focusing on academic science only and using a very different study framework and approach.

⁷⁴See tables 2 and 3 in Narin, Hamilton, and Olivastro (1997).

Text table 5-13. Number and distribution of citations on U.S. patents to the U.S. scientific and technical literature, by field

		Clinical	Biomedical			E	Earth & space	Engineering &	
Patent issue year	Total	medicine	research	Biology	Chemistry	Physics	sciences	technology	Mathematics
			Nur	mber of ci	tations				
1987	8,597	2,221	2,391	168	1,181	1,286	104	1,244	0
1988	9,495	2,423	2,749	220	1,212	1,595	81	1,211	2
1989	12,950	3,193	3,978	304	1,536	2,356	117	1,461	2
1990	12,906	3,417	3,818	306	1,673	2,169	76	1,443	3
1991	15,718	4,208	5,199	437	1,921	2,424	123	1,401	2
1992	19,404	5,294	6,949	436	2,451	2,667	92	1,494	18
1993	26,694	7,393	10,736	547	3,027	3,024	93	1,850	21
1994	27,422	7,223	10,334	675	3,114	3,589	121	2,349	14
1995	32,500	9,171	12,713	812	3,689	3,366	134	2,593	19
1996	47,059	13,630	20,617	1,344	4,533	3,498	193	3,215	25
			Perce	entage of	citations				
1987	100	26	28	2	14	15	1	14	0
1988	100	26	29	2	13	17	1	13	0
1989	100	25	31	2	12	18	1	11	0
1990	100	26	30	2	13	17	1	11	0
1991	100	27	33	3	12	15	1	9	0
1992	100	27	36	2	13	14	0	8	0
1993	100	28	40	2	11	11	0	7	0
1994	100	26	38	2	11	13	0	9	0
1995	100	28	39	2	11	10	0	8	0
1996	100	29	44	3	10	7	0	7	0

NOTE: Count for 1987 patents is of citations to articles published in 1973-84; for 1988 patents to articles published in 1974-85, etc.

See appendix table 5-56.

Science & Engineering Indicators - 1998

Patents Awarded to U.S. Universities

Patents may be awarded on the results of academic R&D deemed to have potential utility for the development of new or improved products or processes. While the bulk of academic R&D is basic research (i.e., research that is not undertaken to yield or contribute to immediate practical applications), data on the patenting activities of universities and colleges suggest that academic institutions are giving increased attention to the potential economic benefits that may be inherent in their R&D results. A growing number of universities and colleges are applying for, and receiving, protection for results of work conducted under their auspices, even though the returns on such patents remain low, on average, when measured against their R&D expenditures. (See "Income From Patenting and Licensing Arrangements," below.) The number of patents and institutions involved is small when viewed against the backdrop of all U.S. patenting activity, but the increases are of interest.

After slow growth in the 1970s, the number of academic institutions receiving patents increased rapidly in the 1980s from about 73 early in the decade to more than double that by 1989 and 168 by the mid-1990s.⁷⁵ This development, pronounced during the 1980s and more muted in this decade, affected the

number of both public and private institutions receiving patent awards. (See figure 5-31.) Starting in the early 1980s, the number of institutions outside the ranks of the largest research universities (defined here as the top 100 in total 1995 R&D expenditures) with patent awards increased at a rapid pace. While the largest research universities had constituted 70 percent of all academic institutions receiving patents in 1982, their share of all academic institutions had fallen to just half in 1995—signaling a broadening of the institutional base, especially among public universities and colleges. (See appendix table 5-57.) Nevertheless, by 1995, 86 of the top 100 universities in total R&D expenditures received one or more patents.⁷⁶

This expansion of the number of institutions receiving patents coincided with rapid growth in the number of patent awards; this latter rose from 458 in 1982 to 1,860 in 1995. Public institutions expanded their patenting activity somewhat more rapidly than did their private counterparts: the former received 64 percent of newly issued academic patents in 1995, up from 53 percent in 1982. At the same time, the

organizations, separately created entities affiliated with one or more universities, or entities without any university affiliation. This discussion is based on data aggregated in consistent fashion to individual institutions or university systems, as the case may be, starting in the 1980s.

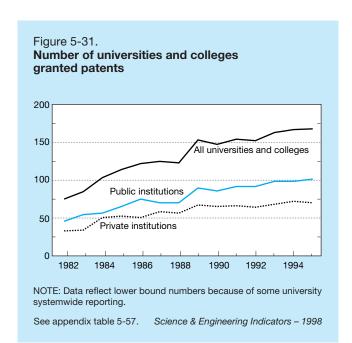
⁷⁵No exact count or correlation with research dollars spent is possible, since patent ownership patterns depend on individual university or university system practices, which vary across institutions and over time. Patents may be assigned to boards of regents, individual campuses, subcampus

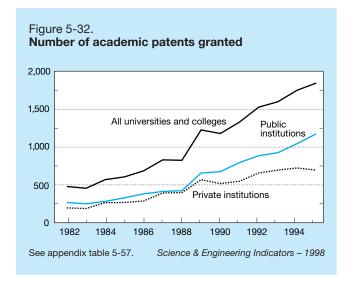
⁷⁶ This is a minimum estimate, since patent awards to some universities—e.g., University of California campuses—are generally recorded at the system level.

top 100 R&D-performing institutions increased their share of the expanding academic patent base from about three-quarters to over 80 percent of the total, where it has leveled off. (See appendix table 5-57.)

The number of academic patents rose more than sevenfold in just over two decades, from about 250 annually in the early 1970s to more than 1,800 in 1995. (See figure 5-32.) This is a far more rapid increase than for all annual U.S. patent awards, which roughly doubled over the period. As a result, academic patents now constitute about 3 percent of all new awards, up from less than one-half of 1 percent two decades ago. A change in U.S. patent law may have contributed to the strong rise in the 1980s; the law now allows academic institutions and small businesses to retain title to inventions resulting from federally supported R&D. Other contributing factors may be the creation of specialized university technology transfer and patenting units, an increased focus on commercially relevant technologies, and closer ties between scientific and engineering research and technological development (see Henderson, Jaffe, and Trajtenberg 1995).

Patents are assigned to utility classes according to their likely areas of application. The distribution of all patents over these areas has evolved slowly, but for academic patents, two pronounced changes have taken place. The growth in the number of academic patents was accompanied by a decrease in the number of utility classes in which they fall. In addition, academic patents are more heavily concentrated in relatively few application areas than are all U.S. patents. This is not surprising, since many patents in many application areas are not science-based at all. Nevertheless, the concentration is remarkable. Over the entire period covered by the database, 1969-95, utility classes in which universities were at least twice as likely as others to be awarded patents accounted for 12 percent of all patents, but half of all academic patents. (See appendix table 5-58.) A heavy concentration is evident





in areas connected with the life sciences, along with some areas of physics and chemistry. (See appendix table 5-59.) In fact, the fraction of academic patents in just three utility classes—all with presumed biomedical relevance⁷⁷—jumped from 8 percent of the total in the early 1970s to more than a quarter in the mid-1990s. (See figure 5-33.)

Income From Patenting and Licensing Arrangements

Valuation of patents—especially of science-based ones—is difficult. Actual use is uncertain, there is generally no direct connection between an individual patent and an economically valuable product or process, and acquisition of licensing rights may be motivated by protection rather than by intent to use. Nevertheless, universities increasingly are negotiating royalty and licensing arrangements based on their patents. While total reported revenue flows from such licensing arrangements remain low, a strong upward trend points to the confluence of two developments: a growing eagerness of universities to exploit the economic potential of research activities conducted under their auspices, and readiness of entrepreneurs and companies to recognize and invest in the market potential of this research.

A 1992 survey by the U.S. General Accounting Office based on 35 universities found that they had substantially expanded their technology transfer programs during the 1980s. Typical licensees were small U.S. pharmaceutical, biotechnology, and medical businesses. During 1989-90, the reported income flows based on these licenses were modest: a mere \$82 million. A more extensive survey conducted periodically since 1991 (AUTM 1996) reported gross revenue receipts of \$299 million in 1995, compared with \$130 million in 1991. (See text table 5-14.) The survey—while extensive—is not nationally representative; thus, these estimates must be seen as lower bound numbers. Moreover, a portion of these reported revenue increases reflects expanded coverage.

⁷⁷Utility classes number 424 and 514 capture different aspects of "Drug, bio-affecting and body treating compositions"; utility class number 435 is "Chemistry: molecular biology and microbiology."

Text table 5-14. **Overview of academic patenting and licensing activities**

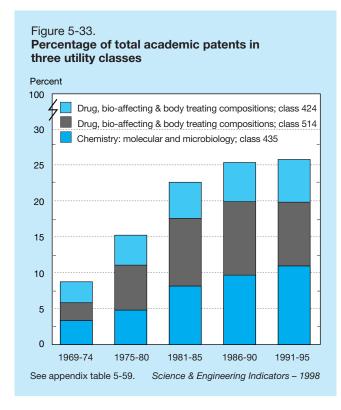
	1991	1992	1993	1994	1995
Gross royalties (million \$)	130	172.4	242.3	265.9	299.1
New research funding from license (million \$)	NA	NA	NA	106.3	112.5
Invention disclosures received	4,880	5,700	6,598	6,697	7,427
New patent applications filed	1,335	1,608	1,993	2,015	2,373
Total patents received	NA	NA	1,307	1,596	1,550
Startup companies formed			916ª	175	169
Number of revenue-generating licenses, options	2,210	2,809	3,413	3,560	4,272
New licenses and options executed	1,079	1,461	1,737	2,049	2,142
Equity licenses and options				464 ^b	99
Royalties paid to others (million \$)	NA	NA	19.5	20.8	25.6
Unreimbursed legal fees expended (million \$)	19.3	22.2	27.8	27.7	34.4
Sponsored research (billion \$)	11.5	12.8	14.9	16.1	17.2
Industry-funded research	0.9	1.0	1.2	1.4	1.4
Federally funded research	8.1	9.1	10.1	10.7	11.4
Number of institutions responding	90	93	115	120	127

NA = not available

NOTES: Figures on patenting differ from those reported for all universities and colleges by the U.S. Patent and Trademark Office since they do not reflect the activities of all U.S. universities and colleges. Data are internally consistent for each year shown but cannot be treated as trend data because of the growing number of institutions participating in the survey and varying nonparticipation of major research universities.

SOURCE: Association of University Technology Managers, Inc., AUTM Licensing Survey, Fiscal Year 1991-Fiscal Year 1995.

Science & Engineering Indicators - 1998



Conclusion

Academic R&D and S&E educational activities have long been a significant part of the U.S. R&D enterprise. R&D spending by universities and colleges is projected to reach \$23.8 billion in 1997, accounting for an estimated 12 percent of total national R&D expenditures. The academic sector also continues to be the single largest performer of basic research, accounting for an estimated 52 percent of national basic research expenditures. The bulk of funding for academic R&D is provided by the Federal Government (60 percent in 1997); the second largest funding source is higher education institutions themselves (19) percent). State and local governments contribute 8 percent of the total, and industry and all other sources combined account for about 7 percent each. The bulk of federal funding is provided by three agencies: the National Institutes of Health with 57 percent, the National Science Foundation with 15 percent, and the Department of Defense with 10 percent.

Extensive physical infrastructure exists in support of academic R&D. About \$3.1 billion in expenditures for constructing new *research facilities* were planned for 1996-97, along with another \$1.3 billion for repair and renovation. Since 1988 (when comparable data first became available), academic S&E research space has increased by 22 percent, to 136 million net assignable square feet. New construction projects initiated between 1986 and 1995 which will either replace existing or add new space are expected to produce over 52 million

^aStartup companies reported to have been formed through 1993.

^bEquity licenses and options granted through 1994.

square feet of research space by the time they are completed. In 1996, deferred construction or renovation projects totaled \$9.3 billion, of which \$7.4 billion was carried on approved construction plans. The major facilities funding sources are state governments (38 percent) and the institutions themselves (23 percent). Expenditures for research equipment were running just below 6 percent of total 1995 R&D expenditures. The major funder of research equipment remains the Federal Government (59 percent in 1995). In 1996, academic institutions rated 37 percent of their research laboratory space as suitable for the most scientifically competitive research; 44 percent as possibly needing some repair or renovation but effective for most levels of research; and 19 percent as needing major repair, renovation, or replacement. Overall, 27 percent of in-use research instruments were judged to be state of the art, another 63 percent as adequate for researcher needs, and 9 percent as inadequate.

About half of the nation's doctoral S&E research workforce was located in academic institutions—roughly 153,500 in 1995, including postdoctorates. The number of academic doctoral scientists and engineers reporting research as their primary work responsibility continued to grow, reaching 83,000 in 1995. Much of the growth, especially since the mid-1980s, occurred outside the traditional research universities; the number of institutions in this segment with federal R&D support reached 654 in 1995, up from 335 in 1975. In the course of their work, academic researchers are supported by, and help train, about 330,000 full-time S&E graduate students. For about 90,000 of them, a research assistantship was their most important means of support in 1995. The Federal Government is the primary source of support for about half of these students. In fact, RAs have grown in importance. The proportion of graduate students with research assistantships as their primary means of support increased from 22 to 27 percent between 1980 and 1995. A larger percentage of graduate students in the physical sciences, the environmental sciences, and engineering rely on RAs as their primary mechanism of support than do students in other disciplines.

Academic researchers produced 71 percent of all U.S.-authored scientific and technical articles in an international core set of peer-reviewed natural science and engineering journals included in the Institute for Scientific Information's Science Citation Index, and 23 percent of the world output published in these journals. (The total U.S. article share in 1995 was 33 percent.) Academic scientists and engineers increasingly collaborate with colleagues elsewhere: in 1995, nearly a quarter of all academic articles involved one or more authors from another U.S. employment sector.

Academic research, though predominantly basic, is increasingly connected with potential practical applications. More than 1,800 patents were awarded to academic institutions in 1995, which represented over 3 percent of all U.S. patent grants in that year. Academic patents were concentrated in a smaller set of application areas than patents of other awardees, with significant strengths in the life sciences, physics, and chemistry. In fact, more than a quarter of all academic patents fell

into only three application areas with presumed biomedical relevance. Income from patenting and licensing agreements continued to grow and reached \$299 million in 1995. And the number of citations to scientific and technical articles on patent applications, which has risen strongly in recent years, exceeded 47,000 in 1996—roughly 26,000 of which were to academic articles.

The increasingly global nature of the scientific and engineering enterprise is reflected in an ubiquitous increase in the number of articles that have authors from more than one country. Roughly half of the 439,000 articles published worldwide in the SCI journal set referred to earlier had authors from multiple institutions, and nearly 30 percent of these multi-author papers involved international collaboration. Two complementary trends characterize the U.S. position. For almost every nation with strong international coauthorship ties, the number of papers involving U.S. researchers rose strongly over the past decade and a half. But during this period, many nations broadened the reach of their international collaborations, leading to a gradual diminution of the U.S. share of articles involving international collaborations.

Citations to scientific and technical articles offer an indication of the perceived utility of the results of previous work in subsequent research. In a given country's literature, citations to local work tend to figure prominently and have less of a time lag than citations to work published abroad. But U.S. authors tend to be cited by scientists in virtually all mature scientific nations in excess of the U.S. world share of articles in chemistry, physics, biomedical research, and clinical medicine; U.S. articles in the remaining fields tend to be cited at or slightly below the U.S. share. But no other country cites the domestic literature as heavily as the United States—67 percent in 1995—probably reflecting, at least in part, the sheer scale of the nation's scientific and technical enterprise.

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Chapter 6 Industry, Technology, and Competitiveness in the Marketplace

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Highlights

INTERNATIONAL ECONOMIC COMPARISONS

- ♦ The U.S. economy continues to rank as the world's largest, and Americans continue to enjoy one of the world's higher standards of living. Japan's economy was less than 18 percent of the U.S. economy in 1960 and trailed several European economies. By 1970, it had grown to be the world's second largest economy, and in 1989, Japan had a gross domestic product (GDP) almost twice that of Germany and equal to nearly 40 percent of U.S. GDP.
- ♦ Comparisons of general levels of labor productivity, measured by GDP per employed person, again show that other parts of the world are quickly closing in on the U.S. lead position. For over 40 years, labor productivity growth in the United States generally trailed that in other countries. In 1960, U.S. GDP per employed person was twice that calculated for most European nations and four times that calculated for Japan. As of 1995, the gap has closed significantly, with labor productivity rates in many European nations nearly equal to that achieved in the United States. Productivity growth in Japan appears to have slowed down some since the early 1990s.

U.S. TECHNOLOGY IN THE MARKETPLACE

- ♦ The United States continues to be the leading producer of high-tech products, responsible for about one-third of the world's production. While its margin of leadership narrowed during the 1980s when Japan rapidly enhanced its stature in high-tech fields, by 1995 U.S. high-tech industries regained world market share lost during the previous decade.
- ♦ The market competitiveness of individual U.S. high-tech industries varies, although each of the industries maintained strong—if not commanding—market positions over the 15-year period examined. Three of the four science-based industries that form the high-tech group (computers, pharmaceuticals, and communications equipment) gained market share in the 1990s. The aircraft industry was the only U.S. high-tech industry to lose market share from 1990 to 1995.
- ♦ U.S. trade in technology products accounts for a much larger share of U.S. exports than U.S. imports; it therefore makes a positive contribution to the U.S. overall balance of trade. After several years in which the surplus generated by trade in technology products declined, preliminary data for 1996 show a larger surplus than in 1995. Between 1990 and 1995, the U.S. trade surplus in software technology doubled. During that same period, trade in aerospace technologies consistently produced large—albeit declining—trade surpluses for the United States.

♦ The United States is also a net exporter of technological know-how sold as intellectual property. Royalties and fees received from foreign firms have been, on average, three times those paid out to foreigners by U.S. firms for access to their technology. U.S. receipts from licensing of technological know-how to foreigners exceeded \$3.3 billion in 1995, up from \$3.0 billion in 1994. Japan is the largest consumer of U.S. technology sold as intellectual property; South Korea is the second largest customer.

INTERNATIONAL TRENDS IN INDUSTRIAL R&D

- ◆ Despite a two-decade decline in its international share of industrial research and development (R&D), the United States remains the world's leading performer of industrial R&D by a wide margin. After 1990, the U.S. share stabilized at 46 percent of total industrial R&D performed by Organisation for Economic Co-operation and Development (OECD) countries. By comparison, the European Union accounted for 30 percent of the total industrial R&D performed by OECD countries during 1990-94; Japan accounted for about 20 percent. Preliminary 1995 data indicate a 1 percentage point rise in U.S. share, a 1 percentage point decline for Japan, and no change for the European Union.
- ♦ The latest internationally comparable data on industry-level U.S. industrial R&D performance show the service sector's share rising from 4 percent in 1982 to 24 percent by 1992. U.S. service sector industries, such as those developing computer software and providing communication services, have led the increase in R&D performance within the U.S. service sector. In 1994, this sector's share of total dropped to around 20 percent. Nevertheless, it still accounts for a larger share of U.S. industrial R&D performance than either the aerospace industry (11.9 percent of total) or the automobile industry (11.2 percent)—the top two R&D-performing industries in the U.S. manufacturing sector in 1994.

PATENTED INVENTIONS

♦ In 1994, for the first time ever, more than 100,000 patents were issued in the United States. This record number of new patented inventions caps off what had been several years of steady increases that began in 1991. In 1995, the number of new U.S. patents granted again topped 100,000, with the final count reaching 101,419. U.S. inventors received 55 percent of the patents granted in 1995; this continues a general upward trend in the proportion of new patents granted to U.S. inventors that began in the late 1980s.

- ♦ Foreign patenting in the United States continues to be highly concentrated by country of origin. In 1995, two countries—Japan and Germany—accounted for over 60 percent of foreign-origin U.S. patents. The top five countries—Japan, Germany, France, the United Kingdom, and Canada—accounted for 80 percent. Several of the newly industrialized economies, notably Taiwan and South Korea, have dramatically increased their patent activity since the late 1980s.
- ♦ Recent patent emphases by foreign inventors in the United States show widespread international focus on several commercially important technologies. Japanese inventors tend to concentrate their U.S. patenting in consumer electronics, photography, photocopying, and—more recently—computer technologies. German inventors continue to develop new products and processes in technology areas associated with heavy manufacturing industries. Inventors from Taiwan and South Korea are earning an increasing number of U.S. patents in communications and computer technologies.
- ♦ Americans successfully patent their inventions around the world. U.S. inventors received more patents than other foreign inventors in neighboring countries (Canada and Mexico) and in distant markets such as Japan, Hong Kong, Brazil, India, Malaysia, and Thailand.
- ♦ International patenting in three important technologies—robot technology, genetic engineering, and advanced ceramics—underscores the inventive activity by the United States, Japan, and Europe. Based on an examination of national patenting in 33 countries during the 1990-94 period, Japan and the United States lead in overall technological activity in these areas. Although South Korea's share of international patent families was lowest overall for the countries examined, it made an impressive showing in each of the technology areas.

VENTURE CAPITAL AND HIGH-TECHNOLOGY ENTERPRISE

- ♦ The pool of venture capital managed by U.S. venture capital firms grew dramatically during the 1980s as venture capital emerged as an important source of financing for small innovative firms. In the 1990s, the venture capital industry experienced a "recession" of sorts as investor interest waned and the amount of venture capital disbursed declined. But this slowdown was short-lived: investor interest picked up in 1992, and disbursements began to rise again.
- ♦ Software companies attracted more venture capital than any other technology area. In 1995, venture capital firms disbursed a total of \$3.9 billion, of which 20 percent went to firms developing computer software or providing

- software services. Medical and health-related companies were second with 14 percent.
- ♦ Very little venture capital actually goes to the struggling inventor or entrepreneur as "seed" money. Over the past 10 years, money given to prove a concept or for early product development never accounted for more than 7 percent of total venture capital disbursements and most often represented 3 to 4 percent of the annual totals. In 1995, seed money accounted for 6 percent of all venture capital disbursements, while money for company expansion garnered 42 percent.
- ♦ As in the United States, venture capitalists in Europe are attracted to young, small, fast-growing companies in need of capital and management expertise. Europe now has venture-capital-backed investments all across the continent, including investments in many of the transitioning countries in Central and Eastern Europe.
- ♦ While computer-related and biotechnology companies in the United States garner the lion's share of U.S. venture capital, the types of firms attracting venture capital in Europe are less technology intensive. Europe has long held a reputation for excellence in industrial machinery and equipment, fashion, and leisure products (e.g., sporting goods). These same industries are among the top recipients of European venture capital.
- ◆ European venture capitalists, like their American counterparts, direct only a small portion of capital disbursements as seed money or startup capital. Investments for expanding an existing company's productive capacity, helping a company add a new product line, or enabling a company to acquire an existing business—later stage investments—account for about 85 percent of European venture capital disbursements.

New High-Tech Exporters

◆ Several Asian economies seem headed toward future prominence as technology developers and a greater presence in global high-tech product markets, when a model of leading indicators is applied. Taiwan and South Korea seem best positioned to enhance their stature in technology-related fields and their competitiveness in high-tech markets. Malaysia and the Philippines scored surprisingly well in many areas and could be the next Asian "tigers," although the model suggests that their technological foundations are still less developed and narrower than those found in either Taiwan or South Korea. Recently, several Asian nations have faced turmoil in their banking systems and capital markets. It is unclear how these developments will affect Asian economies and their science and technology capabilities.

Introduction

Chapter Background

A nation's competitiveness is often judged by its ability to produce goods that find demand in the international marketplace while simultaneously maintaining—if not improving—the standard of living of its citizens (OECD 1996). Science and engineering (S&E), and the technological developments that emerge from S&E activities, enable high-wage nations like the United States to compete alongside low-wage countries in today's increasingly global marketplace. Although the U.S. economy continues to rank as the world's largest, and Americans continue to enjoy one of the world's higher standards of living, many other parts of the world are closing the gap. (See figure 6-1 and appendix tables 6-1, 6-2, and 6-3.)

This chapter highlights the unique role played by industry within the nation's science and technology (S&T) enterprise as it develops, uses, and commercializes investments in S&T made by industry, academia, and government. Within the chapter, indicators or proxies identify trends that provide measurements of industry's part in the nation's S&T enterprise and, wherever possible, place U.S. activity and standing in the more science-based industries in a global context.

Chapter Organization

This chapter begins with a review of the market competitiveness of industries that rely heavily on research and development (R&D); these are often referred to as high-technology industries.¹ The importance of high-tech industries is linked to their high R&D spending and performance which produce innovations that spill over into other economic sectors; additionally, these industries help train new scientists, engineers, and other technical personnel (see Nadiri 1993 and Tyson 1992). The market competitiveness of a nation's technological advances, as embodied in new products and processes associated with these industries, can also serve as an indicator of the effectiveness of that country's S&T enterprise. The market-place provides a relevant economic evaluation of a country's use of science and technology.

U.S. high-tech industry competitiveness is assessed through an examination of market share trends worldwide, at home, and in various regions of the world. New data on royalties and fees generated from U.S. imports and exports of technological know-how are used to gauge U.S. competitiveness when technological know-how is sold or rented as

intangible (intellectual) property.

The chapter explores several leading indicators of technology development (1) via an examination of changing emphases in industrial R&D among the major industrialized countries and (2) through an extensive analysis of patenting trends. New information on international patenting trends of U.S. foreign inventors in several important technologies is presented.

The chapter also presents information on trends in venture capital disbursements. Venture capital is an important source of funds used in the formation and expansion of small high-tech companies. This section examines venture capital disbursements by stage of financing and by technology area in the United States and in Europe.

The chapter concludes with a presentation of leading indicators that are designed to identify those developing and transitioning countries with the potential to become more important exporters of high-technology products over the next 15 years.

U.S. Technology in the Marketplace

Most countries in the world acknowledge a symbiotic relationship between national investments in S&T and competitiveness in the marketplace: science and technology support business competitiveness in international trade, and commercial success in the global marketplace provides the resources needed to support new science and technology. Consequently, the health of the nation's economy becomes a performance measure for the national investment in R&D and in science and engineering. (See "Comparing National Efforts at Technology Foresight.")

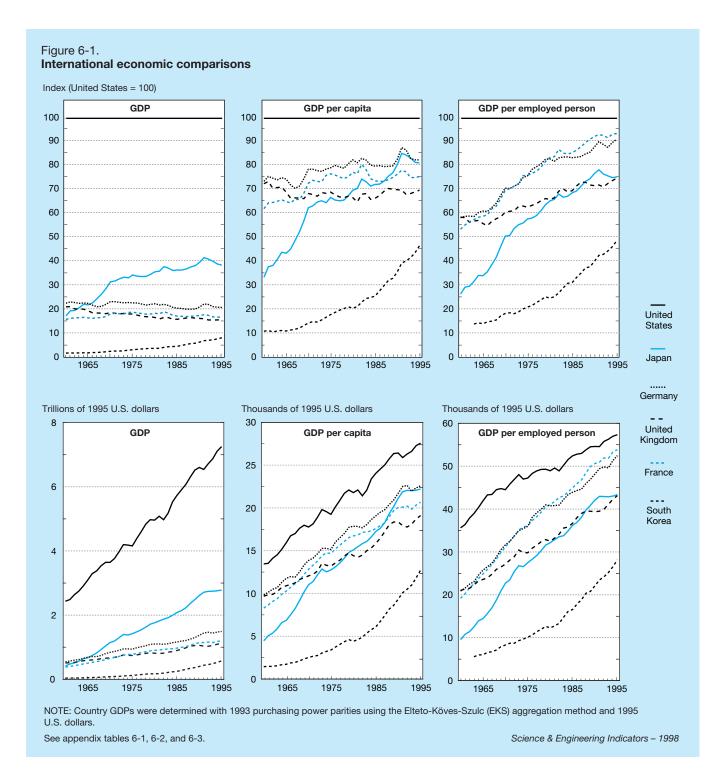
This section discusses U.S. "competitiveness," broadly defined here as the ability of U.S. firms to sell products in the international marketplace. A great deal of attention is given to science-based industries producing products that embody above-average levels of R&D in their development (hereafter referred to as *high-tech industries*). The Organisation for Economic Co-operation and Development (OECD) currently identifies four industries as high-tech based on their high R&D intensities: aerospace, computers and office machinery, electronics-communications, and pharmaceuticals.²

There are several reasons why high-tech industries are important to nations.

♦ High-tech firms are associated with innovation. Firms that

¹In this chapter, high-tech industries are identified using R&D intensities calculated by the Organisation for Economic Co-operation and Development. There is no single preferred methodology for identifying high-technology industries. The identification of those industries considered to be high-tech has generally relied on a calculation comparing R&D intensities. R&D intensity, in turn, has typically been determined by comparing industry R&D expenditures and/or numbers of technical people employed (i.e., scientists, engineers, technicians) to industry value added or to the total value of its shipments.

²In designating these high-tech industries, OECD took into account both direct and indirect R&D intensities for 10 countries: the United States, Japan, Germany, France, the United Kingdom, Canada, Italy, the Netherlands, Denmark, and Australia. Direct intensities were calculated by the ratio of R&D expenditure to output (production) in 22 industrial sectors. Each sector was given a weight according to its share in the total output of the 10 countries using purchasing power parities as exchange rates. Indirect intensity calculations were made using technical coefficients of industries on the basis of input-output matrices. OECD then assumed that for a given type of input and for all groups of products, the proportions of R&D expenditure embodied in value added remained constant. The input-output coefficients were then multiplied by the direct R&D intensities. For further details concerning the methodology used, see OECD (1993).



innovate tend to gain market share, create new product markets, and/or use resources more productively (NRC 1996 and Tassey 1995).

♦ High-tech firms are associated with high value-added production and success in foreign markets, which helps to support higher compensation to the workers they employ. (See "High-Tech Industries Continue to Show Higher Value Added Than Other Manufacturing Indus-

tries.")

♦ Industrial R&D performed by high-tech industries has other spillover effects. These effects benefit other commercial sectors by generating new products and processes that can often lead to productivity gains, business expansions, and the creation of high-wage jobs (Nadiri 1993, Tyson 1992, and Mansfield 1991).

Comparing National Efforts at Technology Foresight

Technology foresight is a tool used by many nations in the S&T priority-setting process. It can be defined as a systematic process for looking into the future to identify important technologies for the purpose of aiding in policy formation, planning, and decisionmaking. Most of the national technology foresight exercises conducted in recent years have involved the administration of a Delphi survey or the generation of a list of critical technologies. Whatever the methodology used, the findings of most of these exercises have included the identification of important technologies and an assessment of relative national position in those technologies identified as important.

The Delphi survey approach to technology foresight attempts to forecast technological developments over the long-term (20- to 30-year) future. First developed by the RAND Corporation in the 1950s, Delphi survey techniques have been used for technology foresight purposes in Japan since 1971 and in Germany, France, and the United Kingdom over the past decade. In the Delphi process, many experts receive two or more rounds of surveys in which they are asked to respond to a detailed questionnaire covering different technological developments. The technological developments themselves are not considered to be inherently important; they are only the starting points on which the survey is based. Respondents are asked to rate each development on several measures, including degree of importance for factors such as wealth creation or quality of life and expected date of realization. Respondents are also asked to rate the relative position of different countries in each technological development, based on a certain criterion such as level of R&D activity. Between survey rounds, the experts receive a summary of all responses to allow them to reconsider their assessments in light of those provided by their peers.

The *critical technologies approach* involves the generation of a list of technologies deemed critical for a country's future. Most lists also provide assessments, based on expert opinion, of relative national position in those technologies identified as critical. In recent years,

critical technologies lists have been developed in the United States, Germany, and France. The definition of critical, the criteria for determining criticality, and the criteria for making assessments of national position vary by study. Among the factors considered in different studies are the importance for economic competitiveness, effect on the environment, relevance for national security, and contribution to the quality of life. Critical technologies are sometimes defined as those that are generic, or "precompetitive," and that have the potential for application in many industrial sectors. Lists of critical technologies are usually developed using a time frame of about 10 years.

Across these different types of national foresight studies, there is some agreement about which categories are useful for classifying important future technologies. The broad technological categories considered important in most studies include biotechnology and life sciences, energy, environment, transportation, information and communications, manufacturing processes, management and business, and materials.

Nations have designated different subfields within these broad technological categories as important to them; this complicates further attempts at comparing the various national technology assessments. Some technologies, however, have been identified by several studies as important; these include advanced ceramics, nanotechnology, biocompatible materials, nuclear waste storage, broadband communications, optical technology, catalysis, renewable energy, flat display technology, semiconductors, intelligent transportation systems, and signal processing.

Besides identifying important technologies and the categories under which these can be classified, most foresight exercises also address the issue of national position in important S&T fields. Self-assessments of relative position are made at both the category and individual technology levels. However, these assessments are difficult to compare across countries because they use different methodologies, criteria, and measures. (See text table 6-1.)

The Importance of High-Technology Industries

The global market for high-tech goods is growing at a faster rate than that for other manufactured goods, and economic activity in high-tech industries is driving national economic growth around the world.³ Over the 15-year period examined

(1980-95), high-tech production grew at an inflation-adjusted average annual rate of nearly 6 percent compared with a rate of 2.4 percent for other manufactured goods. Global economic activity was especially strong at the end of the period (1993-95), when high-tech industry output grew at over 8 percent per year—more than twice the rate of growth for all

³The WEFA/ICF Global Industry Model database reports production data by 68 countries and accounts for over 97 percent of global economic activity.

⁴Service sector industries grew at an average annual inflation-adjusted rate of 3.3 percent during this period.

Text table 6-1.

Comparison of assessments of relative technological position in international foresight exercises

	U.S. critical technologies	Japanese Delphi	German Delphi	French Delphi	U.K. Delphi	French critical technologies	German critical technologies	Australia foresight study
Type of position assessed	Technological position	R&D level	R&D leadership	R&D leadership	S&T capability (also innovation capacity, production capability or service delivery, and exploitation and commercia- lization potential)	Scientific position (also industrial position)	Competitive position	Share of international scientific publications and citations
Countries	U.S., Japan,	Japan, "other	Germany,	France,	United	France ^c	Germany	Australia
compared	and Europe ^a	countries"	Japan, U.S., "other countries"	Germany, Japan, U.S. ^b	Kingdom			
Measurement	U.S. has a	Measured	Measured	Measured	Measured	Strong	Strong	Position
scale used	substantial lead	as mean percentage of respondents, across topics,	as mean percentage of	as mean percentage of	as mean percentage of respondents, across topics, saying that the:	· ·	Average Limited	assessed relative to other
	U.S. has a slight lead		respondents, across topics, saying that:	respondents, across topics, saying that:				scientific areas and interpreted
	U.S. is on par	saying that:						as:
	U.S. slightly lags	Japan is more	Germany is	France is	U.K. is at			Strong
	U.S. substan-	advanced	the leader	the leader	leading edge			Average
	tially lags	Japan is equivalent to	Japan is the leader	Germany is the leader	U.K. is an average			Weak
		other countries	U.S. is the	Japan is	performer			
		Other countries are more		the leader	U.K. is lagging behind			
		advanced	Other countries are leaders	U.S. is the leader	Defilific			

NOTES: Foresight reports are from the following sources: U.S.—U.S. Office of Science and Technology Policy (U.S. OSTP) National Critical Technologies Report (Washington, DC: National Critical Technologies Panel, 1995); Japanese—National Institute of Science and Technology Policy (NISTP), The Fifth Technology Forecast Survey—Future Technology in Japan, NISTP Report No. 25 (Tokyo: Science and Technology Agency, 1992); German Delphi—NISTP and Fraunhofer Institute for Systems and Innovation Research, Outlook for Japanese and German Future Technology: Comparing Japanese and German Technology Forecast Surveys, NISTP Report No. 33 (Tokyo: Science and Technology Agency, 1994); French Delphi—Ministère de l'Enseignement Supérieur et de la Recherche, Enquéte sur les Technologies du Futur par la Méthode Delphi: Présentation des Résultats Synthèse et Commentaires (Strasbourg: BETA, CNRS, Université Louis Pasteur, 1995) [note that this report was not completely accepted by the French Government because of methodological concerns]; U.K.—D. Loveridge, L. Georghiou, and M. Nedeva, United Kingdom Technology Foresight Programme: Delphi Survey (London: HMSO, 1995); French critical technologies—Ministère de l'Industrie, Les Technologies Clés pour l'Industries Française à l'Horizon 2000 (Paris: 1995); German critical technologies—Ministère de l'Industrie, Les Technology Analysis and Strategic Management, Vol. 6, No. 4: 379-409; and Australian—ASTEC, Developing Long-Term Strategies for Science and Technology in Australia: Findings of the Study Matching Science and Technology to Future Needs 2010 (Canberra: AGPS, 1996).

^aEurope's position is "treated as an aggregate and assessments are based on the best demonstrated capability in any European country rather than on average across countries" (U.S. OSTP 1995, p. 191).

^bThe French Delphi also gave respondents the choice of "other countries," but the report did not include those responses in all calculations for methodological reasons.

^cThe French critical technologies report also assessed the scientific and industrial positions of Europe.

SOURCE: Based on the analysis and synthesis of national technology foresight reports in Mogee Research & Analysis Associates, "SGER: Comparing Assessments of National Position in Key Science & Technology Fields," report prepared under National Science Foundation SGER Grant No. SRS-9618668 (Washington, DC: 1997).

Science & Engineering Indicators – 1998

other manufacturing industries. (See figure 6-2 and appendix table 6-5.) Output by the four high-tech industries—those identified as being the most research intensive—represented 7.6 percent of global production of all manufactured goods in 1980; by 1995, this output represented 12 percent.

During the 1980s, the United States and other high-wage countries increasingly moved resources toward the manufacture of technology-intensive goods. In 1989, U.S. high-tech manufactures represented nearly 13 percent of total U.S. pro-

duction of manufactured output, up from 10.4 percent in 1980. High-tech manufactures also accounted for growing shares of total production for European nations, but the transition to high tech in Europe during the 1980s was most prominent in the United Kingdom's economy. High-tech manufactures represented just 9 percent of the United Kingdom's total manufacturing output in 1980, but jumped to 13 percent by 1989. The Japanese economy led all other major industrialized countries in its concentration on high-tech industries. In 1980, high-

High-Tech Industries Continue to Show Higher Value Added Than Other Manufacturing Industries

By definition, the concept of manufacturing value added seeks to measure the contribution of manufacturing activity to a nation's economy (as measured by gross domestic product). (See Greenwald and Associates 1984 and Pearce 1983.) At the firm level, the measurement nets out (removes) from the value of the final output the value of purchased inputs to the production process. At the national level, the measurement nets out foreign-supplied inputs from the value of the nation's final output—thereby determining domestic content of production for an industry or set of industries.

New data from OECD permit comparison of domestic content in high-tech industries and all other manufacturing industries for several countries. Examination of these data shows that high-tech industries continue to incorporate more domestic content in their manufacturing operations than do other manufacturing industries; this trend, however, is not consistent for all countries nor necessarily true for each of the four high-tech industries (i.e., aircraft, communications, office and computers, drugs and medicines). (See text table 6-2.) For example, about 43 percent of the final output by U.S. high-tech industry in 1993 is attributed to domestic value added, compared with 35 percent in all other U.S. manufacturing industries. The difference in value added as a proportion of final output between these two sectors was much larger in Germany and much less in Japan.

Within each country, trends for individual high-tech industries varied. The U.S. drugs and medicines industry, at 56 percent, had the highest ratio of value added among the four U.S. high-tech industries in 1993; the computer/office hardware industry showed lower value added in its U.S. manufacturing operations (about 28 percent) than the average for all other manufacturing. The relative value-added profile for Japan's high-tech industries was similar to that of the United States.

The impact of the global economy is also apparent from an examination of these data. In high-wage countries like the United States and Germany, domestic content in manufacturing industries fell between 1973 and 1993, while domestic content rose in lower wage countries such as South Korea and Spain. (See appendix table 6-4.)

Text table 6-2.

Proportion of manufacturing
final output attributed to domestic content
(value added/production)
(Percentages)

	1973	1983	1993
United States			
Total manufacturing	37.4	33.8	36.1
High-tech manufacturing	44.7	46.1	42.6
Aircraft	42.1	49.4	32.6
Communications	44.3	45.0	51.1
Office & computers	44.5	37.7	27.9
Drugs & medicines	54.2	54.2	56.4
Other manufacturing	36.8	32.3	35.1
Japan			
Total manufacturing	33.5	31.5	37.1
High-tech manufacturing	40.6	37.9	37.2
Aircraft	47.1	43.8	41.7
Communications	37.5	34.8	34.8
Office & computers	35.6	34.3	31.7
Drugs & medicines	58.7	58.0	61.8
Other manufacturing	32.9	30.7	37.1
Germanya			
Total manufacturing	37.4	35.9	37.1
High-tech manufacturing	52.4	54.5	48.9
Aircraft	45.8	39.0	42.7
Communications	50.0	53.3	48.0
Office & computers	83.1	76.4	55.4
Drugs & medicines	47.9	51.5	49.7
Other manufacturing	36.4	34.5	36.0

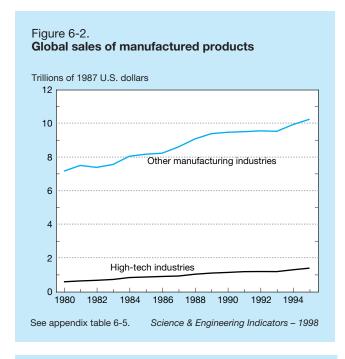
NA = not available

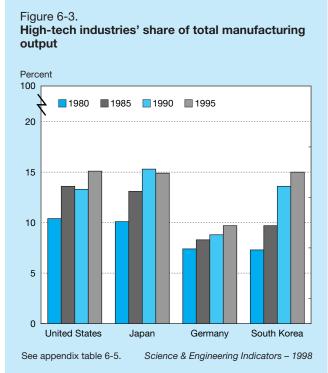
^aGermany's data are for 1976, 1983, and 1992; data for all but 1992 are for West Germany only.

See appendix table 6-4. Science & Engineering Indicators – 1998

tech manufactures accounted for about 10 percent of total Japanese production, rose to 13 percent in 1984, and then increased to 15.3 percent in 1989.

Data for the 1990s show an increased emphasis on hightech manufactures among the major industrialized countries. (See figure 6-3.) In 1995, high-tech manufactures are estimated to represent 15 percent of manufacturing output in both the United States and Japan, 14 percent in the United Kingdom, and 10 percent each in France and Germany. Two other Asian countries, China and South Korea, typify how important R&D-intensive industries have become to the newly industrialized economies. In 1980, high-tech manufactures accounted for just 4 percent of China's total manufacturing output; this proportion jumped to 11.4 percent in 1989 and then reached 12.5 percent in 1995—more than for France or Germany. In 1995, high-tech manufacturing in South Korea accounts for about the same percentage of total output as in Japan and the United States (15 percent).





Share of World Markets

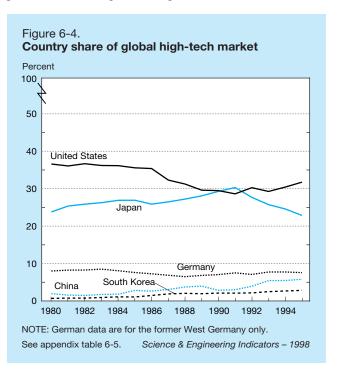
Throughout the 1980s, the United States was the leading producer of high-tech products, responsible for over one-third of total world production from 1980 to 1986, and for about 30 percent of world production for the rest of the decade. While U.S. world market share continued to decline into the early 1990s, the downward trend reversed in 1992. The U.S.

share of the world market for high-tech manufactures grew irregularly after 1991. By 1995, U.S. high-tech industries had regained much of the market share lost during the previous decade. (See figure 6-4.) In 1995, production by U.S. high-tech industry accounted for nearly 32 percent of world high-tech production.

While U.S. high-tech industry struggled to maintain market share during the 1980s, the Japanese global market share in high-tech industries followed a path of steady gains. In 1989, Japan accounted for 28 percent of the world's production of high-tech products, moving up 4 percentage points since 1980. Japan continued to gain on the United States until 1991 when, for the first time, it moved past the United States to become the world's leading high-tech producer. Since then, however, Japan's market share has dropped steadily, falling to under 23 percent of world production in 1995 after accounting for more than 30 percent four years earlier.

By comparison, European nations' share of world high-tech production is much lower. Germany produced about 8 percent of world high-tech production in 1980, under 7 percent in 1989, and nearly 8 percent once again by 1995. Shares for both France and the United Kingdom fluctuated between 4 and 5 percent throughout the 15-year period examined.

China has made the most dramatic gains since 1980, although these gains were made in spurts. During the first half of the 1980s, China's market share moved downward, hovering around 2 percent of world high-tech production. By 1989, the country's share had doubled. After a one-year decline down to 2.9 percent in 1990, China's high-tech production increased significantly; by 1995, the country accounted for nearly 6 percent of world high-tech output.

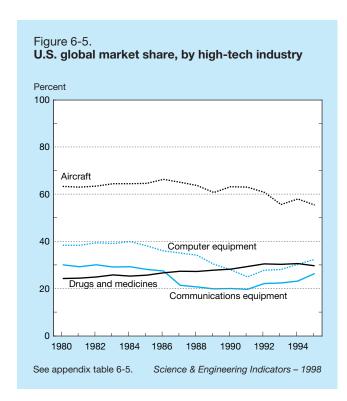


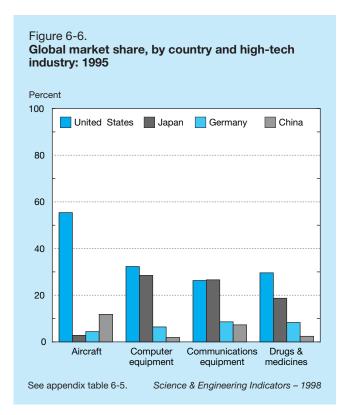
Global Competitiveness of Individual Industries

In each of the four industries that make up the high-tech group, the United States maintained strong, if not leading, market positions over the 15-year period examined. Yet competitive pressures from a growing cadre of high-tech-producing nations contributed to a decline in global market share for three U.S. high-tech industries during the 1980s: aircraft, computers, and communications equipment. Since then, two of these industries—computers and, in particular, communications equipment—have reversed their downward trends and gained market share in the 1990s. (See figure 6-5.)

The U.S. aircraft industry, the nation's strongest high-tech industry in terms of world market share, was the one high-tech industry to lose market share in the 1980s and again in the 1990s. For much of the 1980s, the U.S. aircraft industry supplied about two-thirds of world demand. Within the 1980-95 period, the U.S. share of the world aircraft market peaked in 1986, when it supplied over 66 percent of world demand; it then lost market share nearly every year since. By 1995, the U.S. share had fallen to 55 percent of the world market. (See figure 6-6.) While European aircraft industries gained market share during this time, Chinese industries made especially large gains in global market share beginning in 1992. In 1980, China supplied about 3.5 percent of world aircraft shipments; by 1995, its share had increased to nearly 12 percent.

As previously noted, two U.S. high-tech industries lost market share during the 1980s and then reversed that trend during the 1990s. By 1995, the United States was the number one supplier of computer equipment in the world and in a





virtual tie with Japan for number one in terms of worldwide shipments of communications equipment.

Of the four high-tech industries, only the U.S. pharmaceutical industry managed to retain its number one ranking throughout the 15-year period. It was also the only U.S. high-tech industry that had a larger share of the global market in 1995 than in 1980.

The United States is considered a large, open market. These characteristics benefit U.S. high-tech producers in two important ways. First, supplying a market with many domestic consumers provides scale effects to U.S. producers in the form of potentially large rewards for the production of new ideas and innovations (Romer 1996). Second, the openness of the U.S. market to foreign-made technologies pressures U.S. producers to be inventive and to move toward more rapid innovation in order to maintain domestic market share.

This discussion of world market shares shows that U.S. producers are leading suppliers of high-tech products to the global market. That evaluation incorporates U.S. sales to domestic as well as foreign customers. In the next sections, these two markets are examined separately.

Exports by High-Tech Industries

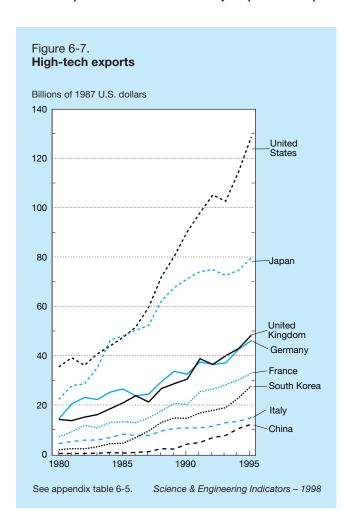
While U.S. producers reaped many benefits from having the world's largest home market (as measured by gross domestic product—GDP), mounting trade deficits have led to concern about the need to expand U.S. exports. U.S. high-tech industries have traditionally been more successful than other U.S. industries in foreign markets. Consequently, high-tech industries have attracted considerable attention from policymakers as they seek ways to return the United States to a more balanced trade position.

Foreign Markets

Despite its domestic focus, the United States has been an important supplier of manufactured products in foreign markets throughout the 1980-95 period. In fact, from 1992 to 1995, the United States was the leading nation exporter of manufactured goods, accounting for between 12.1 and 12.8 percent of world exports. U.S. high-tech industries have contributed to this strong export performance of the nation's manufacturing industries.

Over the same 15-year period, U.S. high-tech industries accounted for between 19 and 26 percent of world high-tech exports—at times twice the level achieved by all U.S. manufacturing industries. The peak was reached in 1980, and U.S. market share has fallen fairly consistently since then. In 1995, the latest year for which data are available, exports by U.S. high-tech industries accounted for 19.2 percent of world high-tech exports; Japan was second, accounting for 11.9 percent; followed by the United Kingdom and Germany, with 7.2 percent and 6.9 percent, respectively.

The drop in U.S. share over the 15-year period is in part

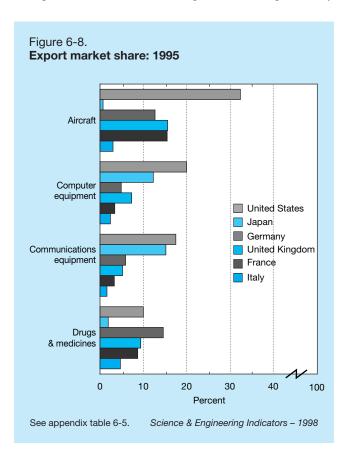


the result of the emergence of high-tech industries in newly industrialized economies, especially within Asia. South Korea is one example. (See figure 6-7.) In 1980, high-tech industries in South Korea accounted for about 1.4 percent of world high-tech exports. That market share doubled by 1986. The latest data for 1995 show South Korea's share reaching 4.1 percent, nearly twice the market share of high-tech exports held by Italy that same year.

Industry Comparisons

Throughout the 15-year period, individual U.S. high-tech industries either led in exports or were second to the leader in each of the four industries included in the high-tech grouping. The most current data, 1995, show the United States as the export leader in three industries and second in just one—drugs and medicines. (See figure 6-8.) As noted in the previous section on global market shares, the U.S. pharmaceutical industry was the only U.S. high-tech industry that consistently led the world in production and that also had a larger share of the world market in 1995 than in 1980. Since global market shares incorporate all shipments—foreign and domestic—this industry's sales to the U.S. market appear to be responsible for its gain in world market share.

In terms of export performance, U.S. industries producing aircraft, computers, and pharmaceuticals all accounted for smaller export shares in 1995 than in 1980. The communications equipment industry was the sole U.S. high-tech industry to improve its share of world exports over the period. By



comparison, the share of world exports held by Japan's communications equipment industry dropped steadily after 1985—eventually falling to 15.2 percent by 1995 from a high of 36.5 percent just 10 years earlier. In addition to gains in world export share by the United States and the United Kingdom, once again the newly industrialized economies of Asia demonstrated an ability to produce high-tech goods to world-class standards and were rewarded with great success in selling to foreign markets. In 1995, South Korea supplied 6.8 percent of world communication product exports, up from just 2.7 percent in 1980. Other Asian newly industrialized economies have demonstrated similar capabilities in communications equipment.

Competition in the Home Market

A country's home market is often thought of as the natural destination for the goods and services produced by domestic firms. For obvious reasons—including proximity to the customer and common language, customs, and currency—marketing at home is easier than marketing abroad.

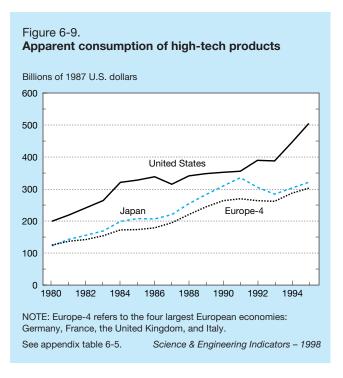
But with trade barriers falling and the number of foreign firms able to produce goods to world standards rising, product origin may only be one factor among many influencing the consumer's choice between competing products. Price, quality, and product performance often become equally important determinants guiding product selection. Thus, in the absence of trade barriers, the intensity of competition faced by domestic producers in their home market can approach—and, in some markets, may even exceed—the level of competition faced in foreign markets. Explanations for U.S. competitiveness in foreign markets may be found in the two dynamics of the U.S. market: the existence of tremendous domestic demand for the latest advanced technology products and the degree of world-class competition that continually pressures U.S. industry toward innovation and discovery.

National Demand for High-Tech Products

Demand for high-tech products in the United States far exceeds that in any other single country and is larger than the combined markets of the four largest European nations (Germany, the United Kingdom, France, and Italy). (See figure 6-9.) This was consistently the case for the entire 1980-95 period. Japan, too, has large domestic demand for high-tech products, and was the second largest market for high-tech products in the world—its demand was much closer in size to that of the United States than to the next largest high-tech market, Germany.

National Producers Supplying the Home Market

Throughout the 1980-95 period, the world's largest market for high-tech products, the United States, was served primarily by domestic producers—yet demand was increasingly met by a growing number of foreign suppliers. (See figure 6-10.) In 1995, U.S. producers supplied about 73 percent of the home market for high-tech products (i.e., aerospace, computers, communications equipment, and pharmaceuticals); however, in 1980, U.S. producers' share was much higher, nearly 92 percent.



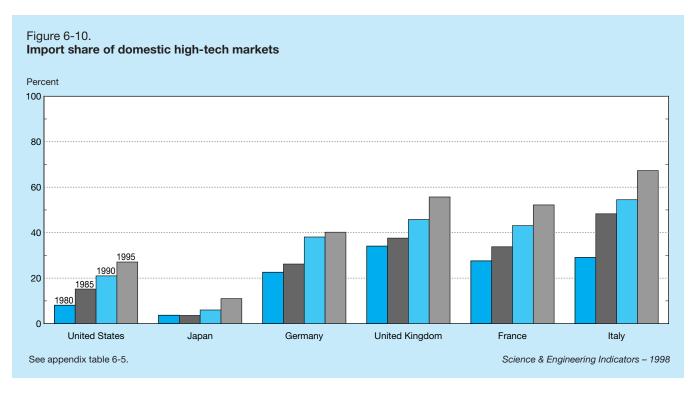
Other countries have experienced similar increased foreign competition in their domestic markets. This is especially true in Europe. A more economically unified European market has had the effect of making Europe an even more attractive market to the rest of the world. Rapidly rising import penetration ratios in the four large European nations during the latter part of the 1980s and throughout the first half of the 1990s reflect these changing circumstances. These data also highlight greater trade activity in European high-tech markets when compared with product markets for less technology-intensive manufactures.

The Japanese home market, the second largest national market for high-tech products and historically the most self-reliant of the major industrialized countries, also increased its purchases of foreign technologies over the 15-year period, albeit slowly. In 1980, imports of high-tech manufactures supplied less than 4 percent of Japanese domestic consumption, rising to 5.6 percent in 1989, and then to 11 percent by 1995.

U.S. Trade Balance

The U.S. Bureau of the Census has developed a classification system for exports and imports of products that embody new or leading-edge technologies. This classification system allows trade to be examined in 10 major technology areas that have led to many leading-edge products. These 10 advanced technology areas are:

- biotechnology—the medical and industrial application of advanced genetic research toward the creation of new drugs, hormones, and other therapeutic items for both agricultural and human uses;
- ♦ life science technologies—application of scientific advances (other than biological) to medical science (for



example, medical technology advances such as nuclear resonance imaging, echocardiography, and novel chemistry, coupled with new production techniques for the manufacture of drugs, have led to new products that allow for the control or eradication of disease);

- opto-electronics—development of electronic products and components that involve emission or detection of light, including optical scanners, optical disk players, solar cells, photosensitive semiconductors, and laser printers;
- ♦ computers and telecommunications—development of products that process increasing volumes of information in shorter periods of time, including fax machines, telephone switching apparatus, radar apparatus, communications satellites, central processing units, computers, and peripheral units such as disk drives, control units, modems, and computer software;
- electronics—development of electronic components (except opto-electronic components), including integrated circuits, multilayer printed circuit boards, and surface-mounted components, such as capacitors and resistors, that result in improved performance and capacity and, in many cases, reduced size;
- computer-integrated manufacturing—development of products for industrial automation, including robots, numerically controlled machine tools, and automated guided vehicles that allow for greater flexibility in the manufacturing process and reduce the amount of human intervention;
- ◆ material design—development of materials, including semiconductor materials, optical fiber cable, and videodisks, that enhance application of other advanced technologies;

- ◆ aerospace—development of technologies, such as most new military and civil airplanes, helicopters, and spacecraft (with the exception of communications satellites), turbojet aircraft engines, flight simulators, and automatic pilots;
- weapons—development of technologies with military applications, including guided missiles, bombs, torpedoes, mines, missile and rocket launchers, and some firearms; and
- ♦ nuclear technology—development of nuclear production apparatus, including nuclear reactors and parts, isotopic separation equipment, and fuel cartridges (nuclear medical apparatus is included in life science rather than this category).

To be included in a category, a product must contain a significant amount of one of the leading-edge technologies, and the technology must account for a significant portion of the product's value.⁵ Because the characteristics of products exported by the United States are likely to differ from the products it imports, experts evaluated exports and imports separately.

The Importance of Advanced Technology Product Trade to Overall U.S. Trade

U.S. trade in advanced technology products accounted for 17 to 20 percent of all U.S. trade (exports plus imports) in merchandise between 1990 and 1996. (See text table 6-3.) Total U.S. trade exceeded \$1.4 trillion in 1996; \$285 billion

⁵The advanced technology product system of trade data discussed here allows for a highly disaggregated, focused examination of technology embodied in traded goods. To minimize the impact of subjective classification, the judgments offered by government experts are subsequently reviewed by external experts.

involved trade in advanced technology products. Trade in advanced technology products accounts for a much larger share of U.S. exports than of imports (25 percent versus nearly 16 percent in 1996) and makes a positive contribution to the overall balance of trade. After several years in which the surplus generated by trade in advanced technology products declined, preliminary data for 1996 show a larger surplus than in 1995. (See figure 6-11 and text table 6-3.)

Technologies Generating a Trade Surplus

Between 1990 and 1995, the U.S. trade surplus in software technology doubled, and trade in computer-integrated manufacturing technologies—those used to automate the manufacturing process—generated a sizable surplus. During this same period, trade in aerospace technologies consistently produced large, albeit declining, trade surpluses for the United States. Aerospace technologies generated a net inflow of \$26 billion in 1990, and almost \$30 billion in 1991 and 1992; the U.S. trade surplus in aerospace technologies then declined 14 percent in 1993, 9 percent in 1994, and 14 percent in 1995. While U.S. aerospace companies continue to lead the world in aircraft production and global shipments, Europe's aerospace industry now challenges U.S. companies' preeminence both at home and in foreign markets. The impact of Europe's Airbus is evident in the trade data. In 1990, U.S. trade in aerospace technologies with Germany, the United Kingdom, France, and Italy produced a \$5.5 billion trade surplus. In 1995, the U.S. trade surplus with Europe was less than half that amount (\$2 billion).

In 1990, opto-electronics and electronics products were the only advanced technology areas that produced net trade deficits for the United States. However, since 1992, the United States has had trade deficits in three areas: opto-electronics, electronics, and computers and telecommunications. Trade deficits with several Asian economies in these three advanced technology areas now exceed the trade surpluses generated from trade with other countries.

Figure 6-11. U.S. trade balance in top three advanced technology products Billions of U.S. dollars 50 40 All advanced technologies 30 20 10 Computers and telecommunications 0 Electronics -10 -20 1995 1990 1991 1992 1993 1994 1996 Science & Engineering Indicators - 1998 See appendix table 6-6.

U.S. Royalties and Fees Generated From Intellectual Property

The United States has traditionally maintained a large surplus in international trade of intellectual property. Firms trade intellectual property when they license or franchise proprietary technologies, trademarks, and entertainment products to entities in other countries. These transactions generate net revenues in the form of royalties and licensing fees.

U.S. Royalties and Fees From All Transactions

U.S. receipts from all trade in intellectual property reached \$26.9 billion in 1995, a 21 percent increase over 1994. The

Text table 6-3. **U.S. international trade in merchandise** (Billions of U.S. dollars)

	1990	1991	1992	1993	1994	1995	1996
Total exports	393.0	421.9	447.5	464.8	512.4	575.9	611.5
Technology products (percent)	24.1	24.1	23.9	23.3	23.6	24.0	25.3
Other merchandise (percent)	75.9	75.9	76.1	76.7	76.4	75.0	74.7
Total imports	495.3	488.1	532.4	580.5	663.8	749.4	799.3
Technology products (percent)	11.0	12.0	13.5	13.0	14.8	16.7	16.3
Other merchandise (percent)	88.0	87.0	86.5	86.0	85.2	83.3	83.7
Total trade	888.3	910.0	979.9	1,045.3	1,176.2	1,325.3	1,410.8
Technology products (percent)	17.3	18.1	18.3	18.1	18.6	19.9	20.2
Other merchandise (percent)	82.7	81.9	81.7	81.9	81.4	80.1	79.8

NOTE: Total trade is the sum of total exports and total imports.

SOURCE: U.S. Bureau of the Census, Foreign Trade Division, << http://www.fedstats.gov>>, 1997.

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1995 surplus continued a steady upward trend, which has resulted in a doubling of U.S. receipts in just six years. (See appendix table 6-7.) During the 1987-95 period, U.S. receipts were generally four to five times as large as U.S. payments to foreign firms for intellectual property. Most (about 75 percent) of the transactions involved exchanges of intellectual property between U.S. firms and their foreign affiliates. (See figure 6-12.)

Exchanges of intellectual property among affiliates continue to grow faster than those among unaffiliated firms. This trend suggests a growing internationalization of U.S. business and a desire to retain a high level of control on any intellectual property leased overseas.

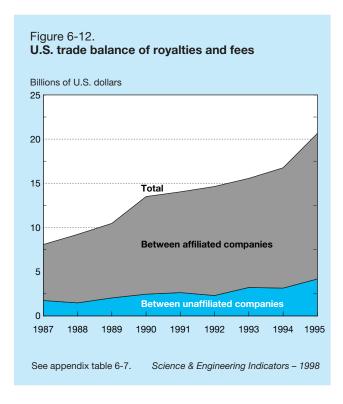
U.S. Royalties and Fees From Trade in Technical Knowledge

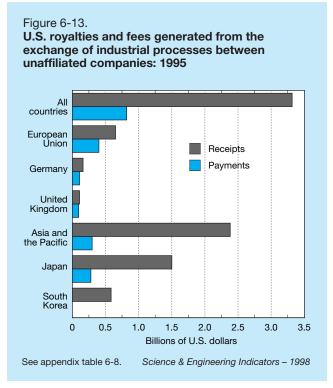
Data on royalties and fees generated by trade in intellectual property can be further disaggregated to reveal U.S. trade in technical know-how. These data describe transactions between unaffiliated firms where prices are set through a market-based negotiation. Therefore, they better reflect the exchange of technical know-how and its market value at a given point in time than do data on exchanges among affiliated firms. When receipts (sales of technical know-how) consistently exceed payments (purchases), these data may indicate a comparative advantage in the creation of industrial technology. The record of resulting receipts and payments also provides an indicator of the production and diffusion of technical knowledge.

The United States is a net exporter of technology sold as intellectual property. Royalties and fees received from foreign firms have been, on average, three times those paid out by U.S. firms to foreigners for access to their technology. U.S. receipts from such technology sales exceeded \$3.3 billion in 1995, up from \$3.0 billion in 1994, and nearly double that reported for 1987. (See figure 6-13 and appendix table 6-8.)

Japan is the largest consumer of U.S. technology sold as intellectual property. In 1995, Japan accounted for over 45 percent of all such receipts, while the European Union (EU) countries together represented about 20 percent. Another Asian country, South Korea, is the second largest consumer of U.S. technology sold as intellectual property; it has maintained that position since 1988, when it accounted for 5.5 percent of U.S. receipts. South Korea's share rose to 10.7 percent in 1990, and to 17.6 percent in 1995.

To a large extent, the U.S. surplus in the exchange of intellectual property is driven by trade with Asia. In 1995, U.S. receipts (exports) from technology licensing transactions were eight times U.S. firm payments (imports) to Asia. As previously noted, Japan and South Korea were the biggest customers for U.S. technology sold as intellectual prop-





erty—together, these countries accounted for over 50 percent of total receipts in 1995.

The U.S. experience with Europe has been very different from that with Asia. Over the years, U.S. trade with Europe in intellectual property has bounced back and forth, showing either a small surplus or deficit each year. In 1995,

⁶An affiliate refers to a business enterprise located in one country that is directly or indirectly owned or controlled by an entity of another country to the extent of 10 percent or more of its voting stock for an incorporated business or an equivalent interest for an unincorporated business.

U.S.-Europe trade produced the largest surplus in the nine years examined, the result of a sharp decline in U.S. purchases of technical know-how from the smaller European countries.

Foreign sources for U.S. firm purchases of technical know-how have changed somewhat over the years, with increasing amounts coming from Japan. Europe still accounts for nearly 60 percent of the foreign technical know-how purchased by U.S. firms, with France, Germany, and the United Kingdom being the principal European suppliers. But, since 1990, Japan has been the single largest foreign supplier of technical know-how to U.S. firms.

International Trends in Industrial R&D

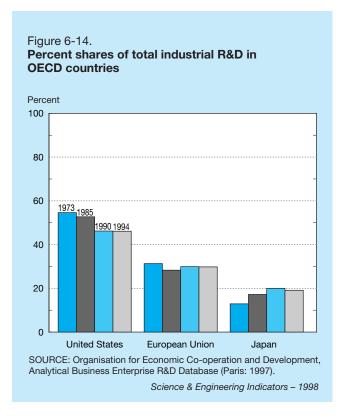
In high-wage countries like the United States, industries stay competitive in a global marketplace through innovation. Innovation can lead to better production processes and better performing products (i.e., those that are more durable, more energy efficient, etc.); it can thereby provide the competitive advantage high-wage countries require when competing with low-wage countries.

R&D activities serve as an incubator for the new ideas that can lead to new products, processes, and industries. While they are not the only source of new innovations, R&D activities conducted in industry-run laboratories and facilities are associated with many of the important new ideas that have helped shape modern technology.

U.S. industries that traditionally conduct large amounts of R&D have met with greater success in foreign markets than less R&D-intensive industries and have been more supportive of higher wages for their employees. Moreover, trends in industrial R&D performance serve as leading indicators of future technological performance. This section examines these R&D trends, focusing particularly on growth in industrial R&D activity in the top R&D-performing industries of the United States and of its two major competitors in the global marketplace, Japan and the European Union. §

Overall Trends

The United States has long led the industrialized world in the performance of industrial R&D. Over the past two decades, however, the U.S. edge has diminished. Specifically, the U.S. share of total industrial R&D performed by all OECD member countries was 55 percent in 1973 and 46 percent in 1994. (See figure 6-14.) Despite this decline, the United



States remains the leading performer of industrial R&D by a wide margin, even surpassing the combined R&D of the 15-nation European Union. For its part, Japan—in keeping with its belief in the economic benefits of investments in R&D—rapidly increased R&D spending in the 1970s and 1980s, which led to a near doubling of its share of total OECD R&D by 1990. Preliminary data for 1995 indicate a 1 percentage point rise in the U.S. share, a 1 percentage point decline for Japan, and no change for the European Union.

R&D Performance by Industry

The United States, the European Union, and Japan represent the three largest economies in the industrialized world and compete head to head in the international marketplace. An analysis of R&D data provides some explanation for past successes in certain product markets, provides insights into future product development, and signals shifts in national technology priorities.¹⁰

United States

R&D performance by U.S. industry followed a pattern of rapid growth during the 1970s, which accelerated during the early 1980s. That growth pattern stalled during the latter part of the decade and into the 1990s. When adjusted for inflation, growth in U.S. industrial R&D performance over the last decade has steadily dropped from only meager growth

⁷See "U.S. Technology in the Marketplace" for a presentation of recent trends in U.S. competitiveness in foreign and domestic product markets.

⁸This section uses data from OECD's Analytical Business Enterprise R&D Database (OECD 1997) to examine trends in national industrial R&D performance. This database tracks all R&D expenditures (both defense- and nondefense-related) carried out in the industrial sector, regardless of funding source. For an examination of U.S. industrial R&D by funding source, see chapter 4.

⁹OECD member countries include Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

¹⁰Industry-level data are occasionally estimated here in order to provide a complete time series for the 1973-94 period.

to actual decline in 1993 and 1994 (by 2.7 and 0.2 percent, respectively, in 1987 constant dollars).

The downturn in growth would be far more dramatic were it not for the growth in R&D performed by U.S. service sector industries. While the growth in R&D performance by U.S. manufacturers has slowed since the mid-1980s, R&D performance by U.S. service sector industries has grown rapidly. (See figure 6-15.) The latest internationally comparable data on overall U.S. industrial R&D performance show the service sector's share rising from 4 percent in 1982 to 24 percent by 1992. The specific industries driving this increase in R&D performance within the U.S. service sector include those developing computer software and providing communication services.

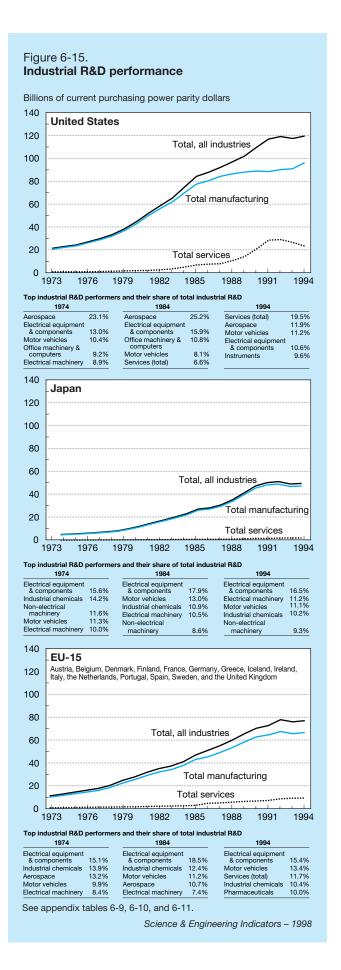
Overall, the U.S. aerospace and communications equipment industries have consistently been the largest performers of R&D in this country. Comparing performance in 1984 and 1994, however, shows a shift in the nation's R&D emphasis. More R&D is being performed in the automotive industry, in the industry producing scientific instruments, and in the service sector industries. Service sector industries as a group accounted for a larger share of U.S. industrial R&D performance than either the aerospace industry or the automobile industry—the top two R&D-performing industries in the U.S. manufacturing sector in 1994.

Japan

During the 1970s, R&D performance in Japanese industries grew at a higher rate than in the United States. Japanese industry continued to expand its R&D spending rapidly through 1985, more than doubling the annualized growth of the previous decade. Japanese industrial R&D spending slowed somewhat during the second half of the 1980s, but the country still led all other industrialized nations in terms of average annual growth in industrial R&D. Unlike the declining trend observed for manufacturing industries in the United States, Japanese manufacturing industries consistently accounted for over 95 percent of all R&D performed by Japanese industry. R&D in Japanese service sector industries appears to have accelerated during the 1990s, but the country's industrial R&D continues to be dominated by the manufacturing sector. (See figure 6-15.)

An examination of growth trends for the top five R&D-performing industries in Japan reflects that country's long-standing emphasis on electronics (including consumer electronics and all types of audiovisual equipment). This industry was the leading performer of R&D throughout the period reviewed. Japan's motor vehicle industry was the third leading R&D performer in 1973, but rose to number two in 1980 and remained at that level through 1992. Japanese automakers earned a reputation for high quality and value during these years, which earned them increasingly larger shares of the global car market.

Electrical machinery producers are also among the largest R&D performers in Japan and have maintained high R&D growth throughout the period examined. By 1994, in fact,



this industry had moved up to become Japan's second leading R&D-performing industry. In comparison, the U.S. electrical machinery industry's ranking among the top R&D performers in the United States has dropped since 1973.

European Union

Like Japan and the United States, manufacturing industries perform the bulk of industrial R&D in the 15-nation European Union. The European Union's industrial R&D appears to be somewhat less concentrated than in the United States, but more so than in Japan. Manufacturers of electronics equipment, industrial chemicals, and motor vehicles have consistently been among the top five performers of industrial R&D in the European Union. (See figure 6-15.) In 1994, Germany led the European Union in the performance of motor vehicle and industrial chemical R&D, while France led in industrial R&D performed by communications equipment manufacturers.

R&D performed by the European Union's service sector has doubled since the mid-1980s, accounting for nearly 12 percent of total industrial R&D performed by 1994. Large increases in service sector R&D are apparent in many EU countries, but especially in the United Kingdom (23.6 percent of its industrial R&D in 1994), Italy (13.8 percent), and France (9.5 percent).

Patented Inventions

New technical inventions have important economic benefits to a nation, as they can often lead to innovations in terms of new or improved products or more efficient manufacturing processes—or even to new industries. To foster inventive activity, nations assign property rights to inventors in the form of patents, which allow the inventor to exclude others from making, using, or selling the invention. Inventors can obtain patents from government-authorized agencies for inventions judged to be new, useful, and non-obvious.

Patent data provide useful indicators of technical change and serve as a means of measuring inventive output over time. 11 Further, U.S. patenting by foreign inventors enables measurement of the levels of invention in those foreign countries (Pavitt 1985) and can serve as a leading indicator of new technological competition (Faust 1984). Patenting trends can therefore serve as an indicator—albeit one with certain limitations—of national inventive activities. 12

This section describes broad trends in inventive activity in the United States over time by national origin of owner, patent office class, patent activity, and commerce activity. It discusses U.S. inventor patenting in foreign countries and presents data on international patenting in several "critical" technologies.

U.S. Patenting

In 1994, for the first time ever, more than 100,000 patents were issued in the United States. This record number—101,675—of new inventions resulting in new patents caps off what had been several years of steady increases since 1990. In 1995, U.S. patents granted fell short of the previous year's mark, but not by much. Once again, more than 100,000 patents were granted, with the final count reaching 101,419 in 1995.

Patents Granted to U.S. Inventors

During the mid-1980s, the number of U.S. patents awarded to U.S. inventors began to decline just as the number awarded to foreign inventors began to rise. This of course raised questions about U.S. inventive activity and whether these numbers were yet another indicator of U.S. competitiveness on the decline. By the end of the decade, however, U.S. inventor patenting picked up and continued to increase and outpace foreign inventor patenting in the United States. In 1989, there was a large jump in the number of new patents awarded to U.S. inventors; that year also marked the first time the number of patents awarded to U.S. inventors exceeded 50,000. Except for the following year (1990), the 50,000 barrier was exceeded each year thereafter. In 1995, U.S. inventors received 55,739 patents. (See figure 6-16 and appendix table 6-12.)

Inventors who work for private companies or the Federal Government commonly assign ownership of their patents to their employers; self-employed inventors typically retain ownership of their patents. Examining patent data by owner's sector of employment can therefore provide a good indication of the sector in which the inventive work was done. In 1995, 79 percent of granted U.S.-origin patents were owned by U.S. corporations. (See "Top Patenting Corporations.") This percentage has increased gradually over the years. (14)

Despite these and other limitations, patents provide a unique source of information on inventive activities.

¹¹See Griliches (1990) for a survey of literature related to this point.

¹²Although the U.S. Patent and Trademark Office grants several types of patents, this discussion is limited to utility patents only, which are commonly known as "patents for inventions." Patenting indicators have several well-known drawbacks, including the following:

incompleteness—many inventions are not patented at all, in part be cause laws in some countries already provide for the protection of in dustrial trade secrets;

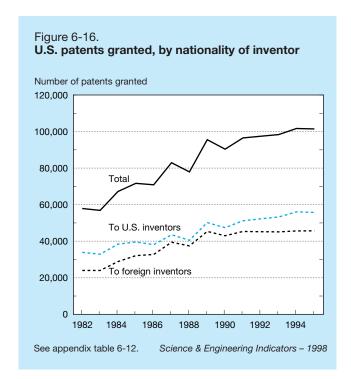
inconsistency across industries and fields—industries and fields vary considerably in their propensity to patent inventions, and consequently, it is not advisable to compare patenting rates among different industries or fields (Scherer 1992); and

inconsistency in quality—the importance of patented inventions can vary considerably (although patent citation rates, discussed later in this section as well as in chapter 5, are one method for dealing with this question of varying quality).

¹³About 3.3 percent of patents granted to U.S. inventors in 1995 were owned by U.S. universities and colleges. The U.S. Patent and Trademark Office counts these as being owned by corporations. For further discussion of academic patenting, see chapter 5, "Patents Awarded to U.S. Universities."

¹⁴Over the past 15 years, corporate-owned patents accounted for between 74 and 79 percent of total U.S.-owned patents.

After business entities, individuals are the next largest group of U.S.-origin patent owners. Prior to 1982, individuals owned, on average, 24 percent of all patents granted. Their share has fluctuated between 23 and 27 percent since then. In 1995, the 23 percent share accounted for by individuals matched similar period lows in 1994. The federal share of patents averaged 3.4 percent of the total during the period 1963-82; thereafter, U.S. Government-owned patents as a share of total U.S.-origin patents declined. U.S. Government-owned patents were encouraged by legislation enacted during the 1980s, which called for U.S. agencies to establish new programs and increase incentives to their scientists, engineers, and technicians that would facilitate the transfer of technology developed in the course of government activities. (See "Private Use of Public Science.")



¹⁵Prior to 1982, data are provided as a total for the period 1963-82.

Top Patenting Corporations

An examination of the top patenting corporations in the United States over the past 23 years underscores the rapid technological transformation achieved by Japan over a relatively short period. In 1973, there were no Japanese companies among the top 10 patenting corporations in the United States. In 1983, there were three Japanese companies among the top 10. By 1993, Japanese companies outnumbered U.S. companies, and the most recent data show eight Japanese companies among the top 10. (See text table 6-4.) Japan's patenting now emphasizes computer technologies, television and communications technologies, and power generation technologies.

Text table 6-4. **Top patenting corporations**

Company N	umber of patents
In 1996	
International Business Machines Corp	1,867
Canon Kabushiki Kaisha	1,541
Motorola Inc	1,064
NEC	1,043
Hitachi, LTD	963
Mitsubishi Denki Kabushiki Kaisha	934
Toshiba Corporation	914
Fujitsu Limited	
Sony Corporation	855
Matsushita Electric Industrial Co., Ltd	841
From 1977-96	
General Electric Corp	16,206
International Business Machines Corp	15,205
Hitachi, LTD	14,500
Canon Kabushiki Kaisha	13,797
Toshiba Corporation	13,413
Mitsubishi Denki Kabushiki Kaisha	10,192
U.S. Philips Corporation	9,943
Eastman Kodak Company	9,729
AT&T Corporation	9,380
Motorola Inc	9,143

SOURCE: U.S. Patent and Trademark Office, Office of Information Systems, TAF Program.

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Patents Granted to Foreign Inventors

Foreign-origin patents represent nearly half (45 percent in 1995) of all patents granted in the United States. ¹⁸ Their share rose throughout most of the 1980s before edging downward in 1989. At their peak in 1988, foreign-origin patents accounted for 48 percent of total U.S. patents. Since then, with U.S. inventor patenting increasing faster than foreign inventor patenting, the foreign inventor share has declined several percentage points. (See appendix table 6-12.)

¹⁶Federal inventors frequently obtain a statutory invention registration (SIR) rather than a patent. An SIR is not ordinarily subject to examination, and it costs less to obtain than a patent. Also, an SIR gives the holder the right to use the invention but does not prevent others from selling or using it as well.

¹⁷The Stevenson-Wydler Technology Innovation Act of 1980 made the transfer of federally owned or originated technology to state and local governments and to the private sector a national policy and the duty of government laboratories. The act was amended by the Federal Technology Transfer Act of 1986 to provide additional incentives for the transfer and commercialization of federally developed technologies. Later, Executive Order 12591 of April 1987 ordered executive departments and agencies to encourage and facilitate collaborations among federal laboratories, state and local governments, universities, and the private sector—particularly small business—in order to aid technology transfer to the marketplace. In 1996, Congress strengthened private sector rights to intellectual property resulting from these partnerships.

¹⁸Corporations account for about 80 percent of all foreign-owned U.S. patents.

Private Use of Public Science

Industry makes good use of public science, according to an analysis of more than 100,000 patent-to-science references conducted by CHI Research, Inc. (see Narin, Hamilton, and Olivastro 1997.) This study showed that 73 percent of the references to scientific publications listed as "prior art" on the front pages of U.S. patents were to public science—i.e., authored at academic, governmental, and other public institutions. (See text table 6-5.) The public science cited in these references was at the basic end of the research spectrum and was "...published in influential journals, authored at top-flight research universities and laboratories, was relatively recent, and heavily supported by NIH [the National Institutes of Health], NSF [the National Science Foundation], and other public agencies" (Narin, Hamilton, and Olivastro 1997). The institutions performing publicly funded research typically produce 90 percent of the articles that appear in the main influential scientific and technical journals. Nevertheless, that so much of it so quickly contributes to private sector technological breakthroughs is an important indicator of the potential economic impact of publicly funded research.

The analysis also found that the number of references to public science had nearly tripled over a recent six-year period (from 1987-88 to 1993-94), suggesting that the linkage between patented technologies and contemporary public science is growing. The availability of better electronic search tools to inventors and patent examiners in the more recent period might help to explain this trend, but researchers do not credit it alone with the tripling of science citations on U.S. patents.

The study concludes that there are strong linkages between contemporary public science and technological breakthroughs patented in the United States, and that these linkages are becoming stronger. These findings are consistent with other indicators of increased linkages and collaborations of industry with academia and national labs. (See chapters 4 and 5.)

Text table 6-5.

Number of citations from 1993-94 U.S. patents to top 15 author institutions

Biomedical papers		Chemistry papers		Physics papers		Engineering & technology papers	
Harvard University 2	,506	MIT	171	Bell Labs	854	Bell Labs	471
National Cancer Institute 1	,279	University of Texas		IBM Corp	566	IBM Corp	428
Veterans Administration 1	,033	at Austin	171	Stanford University	300	University of California-	
University of California-		Harvard University	160	Bellcore	174	Berkeley	189
	930	DuPont Co	142	U.S. Naval Research		MIT	179
Stanford University	920	University of California-		Lab	167	Stanford University	162
University of Washington	845	Berkeley	139	Lincoln Labs	150	General Electric Co	111
MIT	756	Bell Labs	130	MIT	133	Texas Instruments Inc	96
Scripps Clinic & Research		IBM Corp	122	University of Illinois	120	U.S. Naval Research	
Foundation	690	Merck & Co. Inc	102	University of California-		Lab	88
University of California-		Cornell University	96	Santa Barbara	110	North Carolina State	
Los Angeles	642	Texas A&M University	95	Cornell University	106	University	84
Massachusetts	625	Pennsylvania State		University of California-		Bellcore	78
General Hospital		University	89	Berkeley	100	Xerox Corp	69
Johns Hopkins University	610	University of		Xerox Corp	95	University of Illinois	64
Washington University	588	Wisconsin	87	University of Pennsylvania	93	Pennsylvania State	
University of California-	E24	Purdue University	83	North Carolina State		University	60
San Diego	534	University of Illinois	83	University	90	University of California-	50
University of Pennsylvania	517	University of California-		Caltech	87	Los Angeles	59
Merck & Co., Inc	484	Los Angeles	79			Lincoln Labs	57

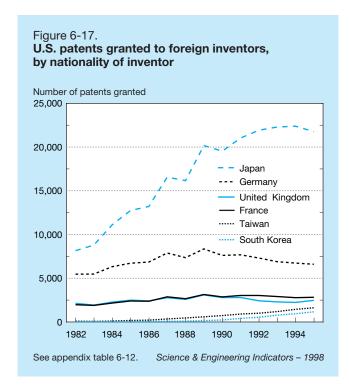
SOURCE: Narin, Hamilton, and Olivastro 1997

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Foreign patenting in the United States is highly concentrated by country of origin. In 1995, two countries—Japan and Germany—accounted for over 60 percent of U.S. patents granted to foreign inventors. The top five countries—Japan, Germany, France, the United Kingdom, and Canada—accounted for 80 percent. (See figure 6-17.) These data show a slowdown in U.S. patenting activity by inventors from these five countries. From 1982 to 1992, U.S. patenting activity by inventors from these five countries nearly doubled, peaking in 1992 at nearly 37,000 U.S. patents. Patenting by Japanese and French inventors was especially strong during this period.

Since then, patenting by inventors from the leading industrialized countries has leveled off and has even begun to decline in some instances. 19 France, Germany, and Japan were each awarded fewer U.S. patents in 1995 than in 1992. The United Kingdom and Canada increased their patenting, but only slightly. Other countries, particularly Asian countries outside Japan, have stepped up their patenting activity in the United States and are showing themselves to be strong inventors of new technologies. This is especially true for Taiwan and South Korea. Before 1982 (data are available starting in 1963), Taiwan was awarded just 316 U.S. patents. Between 1982 and 1995, Taiwan was awarded nearly 9,000 U.S. patents. U.S. patenting activity by inventors from South Korea shows a similar growth pattern. Before 1982, South Korea was awarded just 102 U.S. patents; since then, more than 4,500 new patents have been awarded. Inventors from China and Hong Kong also rapidly increased their patenting in the United

¹⁹Some of the decline in U.S. patenting by inventors from the leading industrialized nations may be attributed to the move toward European unification, which has encouraged wider patenting within Europe.



States since 1982. Even so, when the number of U.S. patents awarded to China and Hong Kong in 1995 are combined, they represent less than one-tenth the number awarded to Taiwan in that year.

Technical Fields Favored by Foreign Inventors

A country's distribution of patents by technical area has proved to be a reliable indicator of a nation's technological strengths, as well as an indicator of direction in product development. This section compares and discusses the various key technical fields favored by inventors in the world's three leading economies—the United States, Japan, and Germany—and in two newly industrialized economies—Taiwan and South Korea.²⁰

Fields Favored by U.S., Japanese, and German Inventors

While U.S. patent activity spans a wide spectrum of technology and new product areas, U.S. corporations' patenting shows a particular emphasis on several of the technology areas that are expected to play an important role in future economic growth (U.S. OSTP 1997). In 1995, corporate patent activity reflected U.S. technological strengths in developing new medical and surgical devices, electronics, telecommunications, advanced materials, and biotechnology. (See text table 6-6 and appendix table 6-13.)

The 1995 patent data continue to show Japanese inventors emphasizing technology classes associated with photography, photocopying, and consumer electronics industries. (See appendix table 6-14.) What is also evident in 1995 is the broader range of U.S. patents awarded to Japanese inventors in information technology. From improved information storage technology for computers to visual display systems, Japanese inventions are earning U.S. patents in areas that aid the processing, storage, and transmission of information.

German inventors continue to develop new products and processes in technology areas associated with heavy manufacturing industries in which that country has traditionally maintained a strong presence. The 1995 U.S. patent activity index shows a German emphasis on motor vehicles, printing, new chemistry and advanced materials, and material handling equipment patent classes. (See appendix table 6-15.) German inventors have also stepped up their patent activity in some newer technology areas, such as biotechnology and opto-electronics.

²⁰Information in this section is based on the U.S. Patent and Trademark Office's classification system, which divides patents into approximately 370 active classes. With this system, patent activity for U.S. and foreign inventors in recent years can be compared by developing an activity index. For any year, the activity index is the proportion of patents in a particular class granted to inventors in a specific country divided by the proportion of all patents granted to inventors in that country. Because U.S. patenting data reflect a much larger share of patenting by individuals without corporate or government affiliation than do data on foreign patenting, only patents granted to corporations are used to construct the U.S. patenting activity indices.

Fields Favored by Two Newly Industrialized Economies

Patent activity in the United States by inventors from newly industrialized economies can be seen as an indicator of these economies' technological development and as a leading indicator of U.S. product markets likely to see increased competition.

As recently as 1980, *Taiwan's* U.S. patent activity was primarily in the area of toys and other amusement devices. By the 1990s, Taiwan was active in such areas as communications technology, semiconductor manufacturing processes, and internal combustion engines (see NSB 1991). The latest available data (1995) show that inventors from Taiwan have continued to patent heavily in communications technologies and processes used in the manufacture of semiconductor devices; data also show heavy activity in computer storage and display devices, advanced materials, and transistors. (See text table 6-7 and appendix table 6-16.) Ten years earlier, inventors from Taiwan received no patents in any of these technology classes.

U.S. patenting by *South Korean* inventors has also shown rapid technological development. The 1995 data show that Korean inventors are patenting heavily in television technologies, electrical products, and advanced materials. (See text table 6-7 and appendix table 6-17.) South Korea's patenting

has also expanded into a broader array of computer technologies that include devices for dynamic and static information storage, data generation and conversion, error detection, and display systems.

Both South Korea and Taiwan are already major suppliers of computers and peripherals to the United States. The recent patenting data show that their scientists and engineers are continuing to develop new technologies and improve existing technologies. It is likely that these new inventions will enhance these economies' competitiveness in the United States and in global markets.

Patenting Outside the United States

In most parts of the world, foreign inventors account for a much larger share of total patent activity than in the United States. When foreign patent activity in the United States is compared with that in 15 other important countries in 1985, 1990, and 1995, only Russia and Japan had less foreign patent activity. (See figure 6-18 and appendix table 6-18.)

What is often obscured by the rising trends in foreignorigin patents in the United States is the success and widespread activity of U.S. inventors in patenting their inventions around the world. U.S. inventors lead all other foreign

Text table 6-6.

Top 15 most emphasized U.S. patent classes for inventors from the United States, Japan, and Germany: 1995

	United States	Japan	Germany
1.	Wells	Dynamic information storage or retrieval	Fluid-pressure brake systems
2.	Surgery (class 606)	Photography	Printing
3.	Surgery (class 604)	Music	Brakes
4.	Surgery: light, thermal, and electrical applications	Photocopying	Conveyors: power driven
5.	Chemistry of hydrocarbons	Facsimile or television recording	Organic compounds (class 548)
6.	Special receptacle or package	Typewriting machines	Metal deforming
7.	Surgery (class 128)	Static information storage and retrieval	Organic compounds (class 546)
8.	Receptacles	Dynamic magnetic information storage or retrieval	Internal-combustion engines
9.	Supports	Active solid state devices	Sheet feeding or delivering
10.	Cryptography	Radiation imagery chemistry: process, composition	X-ray or Gamma ray devices
11.	Static structures (e.g., buildings)	Incremental printing	Plastic or earthenware shaping apparatus
12.	Processes, compositions for food or edible material	Optics: systems and element	Organic compounds (class 568)
13.	Amusement devices: games	Electrical generator	Organic compounds (class 549)
14.	Cleaning and liquid contact with solids	Television	Machine element or mechanism
15.	Chemistry: analytical and immunological testing	Metal treatment	Synthetic resins or natural rubbers (class 528

See appendix tables 6-13, 6-14, and 6-15.

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Text table 6-7.

Top 15 most emphasized U.S. patent classes for inventors from South Korea and Taiwan: 1995

uctor device manufacturing process visual display systems element d seats mp and discharge devices
element d seats
d seats
np and discharge devices
d state devices (e.g., transistors)
nonlinear devices
n
earthenware shaping devices
circuit makers and breakers
smission lines and networks
cles
rmation storage and retrieval

inventors not just in countries neighboring the United States (Canada and Mexico), but also in distant markets such as Japan, Brazil, Hong Kong, India, Malaysia, and Thailand. (See figure 6-19.) Japanese inventors edge out Americans in Germany and the United Kingdom, and dominate foreign patenting in South Korea. German inventors lead all foreign inventors in France, Italy, and Russia; they are also quite active in many of the other countries examined.

International Patenting Trends for Three Important Technologies

This section explores the relative strength of America's technological position by examining international patenting patterns in three important technology areas: advanced manufacturing, biotechnology, and advanced materials.²¹ To facilitate the patent search and analysis, these broad technology areas were each represented by a narrower subfield: robot technology as a proxy for advanced manufacturing, genetic engineering for biotechnology, and advanced ceramics for advanced materials.²² To ensure maximum comparability of

data, this analysis is built around the concept of a "patent family"—i.e., all the patent documents published in different countries associated with a single invention. (See "International Patent Families as a Basis for Comparison.")

International Patent Families as a Basis for Comparison

A patent family consists of all the patent documents associated with a single invention that are published in different countries. The first application filed anywhere in the world is the priority application: it is assumed that the country in which the priority application was filed is the country in which the invention was developed. Similarly, the priority year is the year the priority application was filed. The basic patent is the first patent or patent application published in any of the roughly 40 countries covered in the database used in this section. This database, the Derwent World Patents Index Latest, covers basic patents published from 1981 to the present.

National patent systems, such as Japan's, that encourage large numbers of domestic patent applications skew counts of patent families over time as an indicator of technological activity. To eliminate this bias, international patent families are used as a basis of comparison. An international patent family is created when patent protection is sought in at least one other country besides that in which the earliest priority application was filed.

²¹Data in this section are drawn from a database containing patent records from about 40 major patenting countries, which facilitates a more comprehensive assessment of U.S. technological position vis-à-vis other national competitors. These data were developed under contract for the National Science Foundation by Mogee Research & Analysis Associates; they were extracted from the Derwent World Patents Index database published by Derwent Publications Ltd. The technology areas selected for this study met several criteria:

Each technology appeared on the lists of "critical" technologies considered/deemed important to future U.S. economic competitiveness or national security (see Mogee 1991 and U.S. OSTP 1995).

Each technology is characterized by the output of patentable products or processes.

Each technology could be defined sufficiently to permit construction of accurate patent search strategies.

[•] Each technology yielded a sufficient population for statistical analysis.

²²These subfields were identified based on a review of recent critical technologies reports and extensive consultation with National Science Foundation staff and experts in the technologies to determine representative subfields.

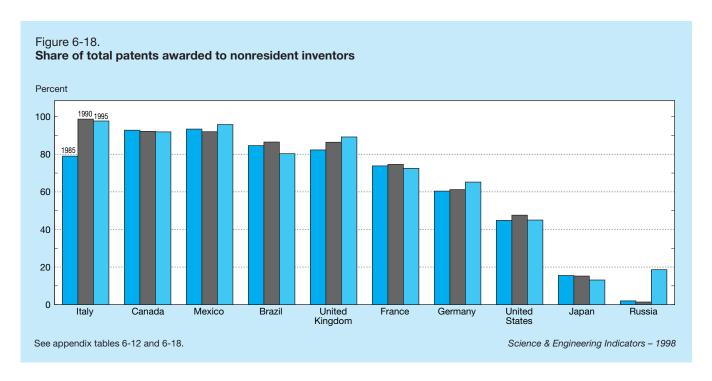


Figure 6-19. Patents granted to nonresident inventors: 1994 India German inventors Thailand Japanese inventors U.S. inventors Malaysia Hong Kong South Korea Brazil United Kingdom France Germany Japan United States 40 100 20 Percentage of nonresident patents See appendix table 6-18. Science & Engineering Indicators - 1998

Three indicators are used here to compare national positions in each critical technology:

- ♦ Trends in international inventive activity—This indicator provides a first measure of the extent and growth of each nation's inventive activity considered important enough to be patented outside of the country of origin. These data are tabulated by priority year.
- ♦ Highly cited inventions—Interpatent citations are an accepted method of gauging the technological value or significance of different patents.²³ These citations, provided by the patent examiner, indicate the "prior art"—i.e., the technology in related fields of invention—that was taken into account in judging the novelty of the present invention.²⁴ The number of citations a patent receives from later patents can serve as an indicator of its technical importance or value. The technological significance indicator used here attempts to assess a country's contribution toward advancing the particular technology field

²³Carpenter, Narin, and Woolf (1981) show that technologically important U.S. patents on average receive twice as many examiner citations as does the average U.S. patent, thus helping to confirm the validity of interpatent citation as an indicator of patent quality.

²⁴The citations counted are those placed on European Patent Office (EPO) patents by EPO examiners. EPO citations are believed to be a less biased and broader source of citations than those of the U.S. Patent and Trademark Office. See Claus and Higham (1982).

by determining the number of highly cited international patent families from each priority country.²⁵

♦ International patent family size—Given the significant costs associated with obtaining patent protection in multiple countries, it can be assumed that the number of countries in which protection has been sought may be indicative of an invention's commercial potential. An indicator attempting to measure the commercial potential of a nation's patented inventions is calculated in two steps: first, by computing mean family size for international patent families by priority country, and then by adjusting the mean family size for the size of the national markets in which protection is being sought.²6

In each technology area, U.S. inventive activity is examined for the 1990-94 period, alongside that of five other countries: Japan, Germany, France, the United Kingdom, and South Korea.

Robot Technology

As used here, robot technology covers programcontrolled manipulators—e.g., the manipulator, program control, gripping heads, joints, arm sensors, safety devices, and accessories—and excludes non-program-controlled manipulators, prosthetic devices, and toy robots.

International Patenting Activity. During the first half of the 1990s, 1,719 international patent families were formed in robotics, with priority applications in the six countries examined. (See figure 6-20.) Patenting activity in the six-country group accounts for about three-quarters of all families in this technology area.

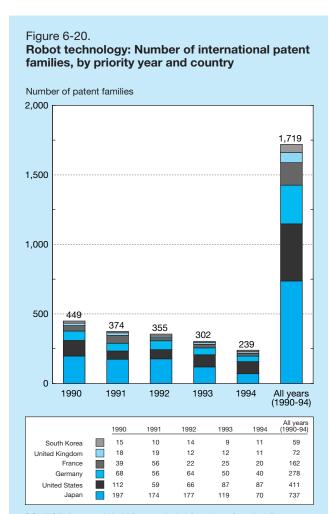
The conventional perception of Japan as an innovator in the area of advanced manufacturing techniques is reinforced by the large number of robot inventions originating in Japan. Japan led all other countries studied in the total number of international patent families in robot technology created during the 1990-94 period. Japanese inventors held 43 percent of the total number of international patent families formed by the six countries included in the study, followed by the United States (24 percent), Germany (16 percent), France (9 percent), the United Kingdom (4 percent), and South Korea (3 percent).

Japan ranks number one in patent activity when the entire five-year period is considered; however, this activity declined rapidly after 1992. At about the same time, U.S. activity picked up; in 1994, the United States led Japan in the number of international robot technology patent families formed.

Although South Korea's share of international patent families was the lowest overall, its share was comparable in size to that of the larger and more advanced economy of the United Kingdom (3.4 percent for Korea versus 4.2 percent for the United Kingdom). Given its newly industrialized economy status, South Korea's overall international inventive activity in this technology area is impressive—especially when the data show that South Korea's patenting activity in this technology area equaled that of the United Kingdom in 1994.

Highly Cited Robot Inventions.²⁷ On this indicator, the United States led all countries—and by a wide margin—with 55.6 percent of all highly cited robot technology international families generated during the 1990-94 period (10 of 18). Japan (with 33.3 percent of the highly cited patents) and Germany (with 11.1 percent) trailed distantly. (See text table 6-8.) The United Kingdom, France, and South Korea did not have any international robot families in the highly cited group.

²⁷This indicator included all families with priority application dates from 1990 to 1994 with eight or more citations.



SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

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²⁵"Highly cited" here means the top 1 percent of international families in terms of the number of citations received. To adjust for the advantage countries with large numbers of international families would have on this indicator, a country's share of highly cited patents are divided by its share of total patent families.

²⁶Operationally, this calculation involves counting the number of countries in a family in which a patent publication (i.e., a published patent application or an issued patent) exists. Patents in each family are weighted by an index based on the GDP in purchasing power parities at current U.S. dollars of the patent country. The index runs from 0 to 1.00, and U.S. GDP is set at 1.00.

Text table 6-8.

Robot technology: International patent families, highly cited patent families, and citation ratios, by priority country: 1990-94

Priority country	Number of international families	Number of highly cited international families ^a	Country share of total (percent)	Country share of highly cited (percent)	Citation ratio ^b
Total	. 1,719	18.0	100.0	100.0	1.0
United States	. 411	10.0	23.9	55.6	2.3
Japan		6.0	42.9	33.3	0.8
Germany	. 278	2.0	16.2	11.1	0.7
United Kingdom	. 162	0.0	9.4	0.0	0.0
France		0.0	4.2	0.0	0.0
South Korea	. 59	0.0	3.4	0.0	0.0

^aAn international patent family was considered highly cited if the number of citations it received ranked it within the top 1 percent compared with all other robot technology international patent families.

^bA citation ratio of greater than 1.0 indicates that a country has a higher share of highly cited international patent families than would be expected based on its share of total families.

SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis
Associates under contract to the National Science Foundation.

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Only the United States had more highly cited international patent families than would be expected—2.3 times—based on its level of activity (i.e., based on the total number of U.S. international robot technology families). None of the other countries studied produced the expected number of highly cited inventions. Specifically, Japan produced only about 80 percent of what might be expected based on the number of inventions it produced during this period, and Germany produced only about 70 percent of what was expected. Again, France, the United Kingdom, and South Korea—with nearly 300 international robot patent families among them—had no highly cited robot inventions during this period.

The United States thus appears to have contributed a disproportionate number of important robot inventions relative to its level of inventive activity. This circumstance also may suggest that even though Japan had a higher number of international robot inventions, U.S. inventions were more technologically important.

Mean International Patent Family Size. This indicator attempts to measure the perceived economic potential of a robot invention by calculating, for each international patent family, the number of countries in which patent protection is being sought, adjusted for market size. When mean international patent family size is calculated for each country's robot technologies, there is not as much separation in the scores as might be expected. (See text table 6-9.) U.S. inventions received the highest score and therefore have the highest level of perceived commercial value based on this measure. South Korean inventions received the lowest score. Since most inventions are first patented in the country in which the inventor resides, U.S. inventions have an advantage in this indicator due to the large size of the U.S.

economy.²⁸ But European inventions also have the advantage of many commercial, locational, and historical ties that facilitate multiple-country patenting. Furthermore, the move toward European unification has encouraged wider patenting within Europe. Still, U.S. inventions scored slightly higher on average than did European robot inventions. Japan's robot inventions also scored well on this indicator, bolstered by the tendency of Japanese inventors to seek patent protection in large economies such as the United States and Germany (79 and 60 percent, respectively). South Korea scored remarkably well, but it too sought patent protection for most of its robot inventions in large markets like the United States (64 percent) and Japan (41 percent).

Genetic Engineering

For this study, genetic engineering is defined as recombinant DNA (rDNA) technology. It includes processes for isolation, preparation, or purification of DNA or RNA; DNA or RNA fragments and modified forms thereof; the introduction of foreign genetic material using vectors; vectors; use of hosts; and expression.²⁹ As used here, genetic engineering does not include monoclonal antibody technology.

²⁸Because of its market size, the United States attracts most commercially important inventions; for this reason, data on U.S. patenting are often used to compare international inventiveness. To overcome differences in national patent systems, the European Commission chose U.S. patent data as a basis for comparing technological output performance of industrial R&D for member countries and stated, "The US is undoubtedly still the most important technological 'market' attracting all major inventions from across the world" (European Commission 1994).

²⁹The trends discussed for genetic engineering technology are based on all genetic engineering international families in the Derwent World Patents Index Latest database, with priority applications in the six countries under study and basic patent publications from 1991 to 1997. These six countries accounted for over 85 percent of the total genetic engineering patent families.

Text table 6-9.

Robot technology: Number of international patent families and average international family size: 1990-94

Priority country	Number of families	Average international family size	Adjusted average international family size ^a
United States	411	7.9	1.6
France	162	8.8	1.4
Japan	737	4.6	1.3
United Kingdom	72	10.1	1.3
Germany	278	8.3	1.2
South Korea	59	2.1	1.0

NOTE: Patent family size is determined by the number of countries for which patent protection is sought for a single invention.

^aPatent family data weighted by an index based on gross domestic product measured in purchasing power parities at current U.S. dollars of the patent country. This weighting adjusts family size for the size of the national markets in which protection is being sought in an effort to better reflect the commercial potential of the invention.

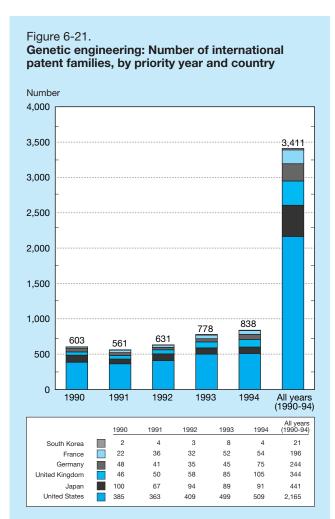
SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

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International Patenting Activity. If the decade of the 1980s generally introduced genetically engineered products to the global marketplace, then the 1990s may become the decade when genetically engineered products come of age. Although slow compared to patenting in the previous decade, the number of international patent families grew steadily from 1991 to 1994, with the largest jump recorded in 1993. (See figure 6-21.) The United States is widely considered the global leader in the biotechnology field, and these data support that perception. The United States is the priority country (location of first patent application) for 63 percent of the internationally patented inventions created during the 1990-94 period; Japan follows with 13 percent, the United Kingdom with 10 percent, and Germany with 7 percent.

When the total number of foreign applications associated with each country's genetic engineering technology is considered, the United States continues to lead all other countries by a wide margin. The United States had more foreign patents than the other five countries combined, accounting for almost 64 percent of the nearly 42,000 foreign patents. The rankings and shares for the other five countries remain the same.

Highly Cited Genetic Engineering Inventions.³⁰ Out of the 3,411 international patent families in genetic engineering formed by the six countries during the 1990-94 period, only



SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

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39 were considered highly cited inventions. The United States, with about 63 percent of the total international patent families recorded during the period, also had the largest proportion of highly cited international patent families—59 percent. (See text table 6-10.) Japan, with 13 percent of the total families, had just 10 percent that were highly cited. The United States, Japan, Germany, and South Korea all produced fewer highly cited patents than expected based on their shares of patent families associated with this technology. The United Kingdom produced the expected number of highly cited inventions based on its share of the total genetic engineering inventions patented internationally (citation ratio equal to 1.0). The only country that exceeded expectations on this indicator was France. France, with far fewer patent families overall than the other countries examined, produced more than three times the number of important or highly cited patents as expected based on its level of activity.

Based on this indicator, the United States leads the other countries in terms of the volume of important (highly cited) genetic engineering inventions it produced during the period

³⁰Operationally, this indicator included all international patent families with priority application dates from 1990 to 1994 with four or more citations.

Text table 6-10.

Genetic engineering: International patent families, highly cited patent families, and citation ratios, by priority country: 1990-94

Priority country	Number of international families	Number of highly cited international families ^a	Country share of total (percent)	Country share of highly cited (percent)	Citation ratio ^b
Total	3,411	39.0	100.0	100.0	1.0
United States		23.0	63.5	59.0	0.9
France	196	7.0	5.7	17.9	3.1
United Kingdom	344	4.0	10.1	10.3	1.0
Japan	441	4.0	12.9	10.3	0.8
Germany	244	1.0	7.2	2.6	0.4
South Korea	21	0.0	0.6	0.0	0.0

^aAn international patent family was considered highly cited if the number of citations it received ranked it within the top 1 percent compared with all other genetic engineering technology international patent families.

^bA citation ratio of greater than 1.0 indicates that a country has a higher share of highly cited international patent families than would be expected based on its share of total international families.

SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

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examined. While it fell slightly short (citation ratio of 0.9) of what might be expected given its share of overall patenting in this technology, the total number of highly cited patents produced by the United States in this important technology area is nevertheless noteworthy.

Mean International Patent Family Size. Patented genetic engineering inventions developed in Japan and Germany appear to be the most commercially valuable, on average, based on this measure, although the scores for each of the countries are similar. (See text table 6-11.) Japan has sought patent protection in 11 countries whose combined economies are equivalent to 1.6 times that of the United States (based on GDP); German-origin inventions average 14.7 countries with a combined GDP equal to 1.5 times that of the United States. Patented genetic engineering inventions originating in the United States rank third in perceived commercial exploitation potential. Inventions originating in France, South Korea, and the United Kingdom all trailed the United States based on this measure.

Advanced Ceramics

National technological positions in the broad field of advanced materials have been assessed through an examination of international patenting activity in advanced ceramics. For this study, advanced ceramics are defined as ceramics (i.e., inorganic, nonmetallic solids) with compositions not usually found in traditional ceramics. These compositions include oxides, carbides, nitrides, and borides, as well as aluminate, titanate, zirconia, and modified silicates. The six countries analyzed represent approximately 90 percent of total international patent family activity by all countries in this technology.

International Patenting Activity. During the 1990-94 period, these six countries generated a total of 968 interna-

Text table 6-11.

Genetic engineering: Number of international patent families and average international family size: 1990-94

Priority country	Number of families	Average international family size	Adjusted average international family size ^a
Japan	441	11.3	1.6
Germany	244	14.7	1.5
United States	2,165	12.8	1.4
France	196	14.9	1.3
South Korea	21	10.0	1.3
United Kingdom	344	12.4	1.0

NOTE: Patent family size is determined by the number of countries for which patent protection is sought for a single invention.

^aPatent family data weighted by an index based on gross domestic product measured in purchasing power parities at current U.S. dollars of the patent country. This weighting adjusts family size for the size of the national markets in which protection is being sought in an effort to better reflect the commercial potential of the invention.

SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

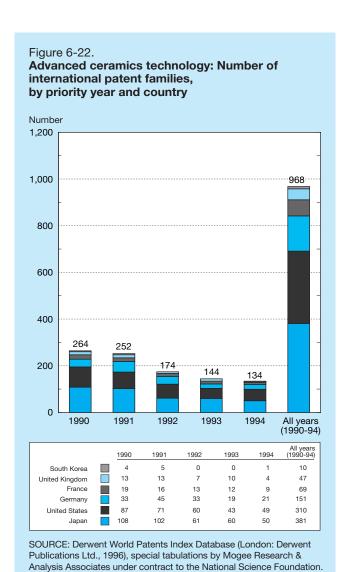
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tional patent families in the field of advanced ceramics. Annual formation of international patent families varied from a high of 264 in 1990 to 134 in 1994, which is the last priority year for which complete data are available.

Japan and the United States lead all other nations in the formation of international patent families involving advanced

ceramics technology. Together they accounted for over 70 percent of the total formed in the five-year period examined. (See figure 6-22.) Japan held 39 percent of the total families formed (with 381 international families) over the period studied; the United States held 32 percent (with 310 international families). Germany, France, and the United Kingdom trailed with 16, 7, and 5 percent of the total, respectively. South Korea held 1 percent of the international patent families in this technology.

When the total number of foreign applications associated with each country's advanced ceramics technology is considered, the United States and Japan switch places, with the United States taking the lead in terms of total number of foreign patents sought for advanced ceramics technology. Out of a total of 7,025 advanced ceramics foreign patents generated from priority applications filed by the six countries during the 1990-94 period, the United States generated 40 percent (2,811 patents); Japan generated 24 percent (1,669 patents).



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Highly Cited Advanced Ceramics Inventions.³¹ Out of the 968 international patent families formed during the 1990-94 period, only 23 were highly cited. Japan generated the greatest number of international patent families in this technology area during the same period, but the United States had the greatest number of highly cited inventions with 15 (or 65 percent of all highly cited international patent families). (See text table 6-12.) Japan was second with four. When each country's number of highly cited international patent families is adjusted to account for its overall volume of international patenting in this technology (citation ratio), the United States again leads all six nations. The United States had a citation ratio of 2.0—that is, twice as many highly cited international patent families as would be expected given its share of total families during the period. Japan's citation ratio, 0.4, suggests that the four highly cited international families it produced during this period were below expectations, given the total number of international patent families the country generated. The United Kingdom had only two highly cited international families, but exceeded expectations in this indicator with a citation ratio of 1.8. France and Germany each had one highly cited international patent family, falling below expectations given their share of total families in this technology.

Mean International Patent Family Size. The advanced ceramics inventions with the highest perceived foreign market potential, on average, were produced in France; these were closely followed by those produced in the United States. (See text table 6-13.) The United States also had the second largest number of international patent families for the period examined. Japan, the most prolific inventor of world-class advanced ceramics technologies during the 1990-94 period, trailed the United States and the large European nations in terms of average commercial potential for each invention. South Korea also trailed the leaders, but still made an impressive showing in this technology area, providing yet another indication of its progress in developing science-based technologies (see NSB 1993, p. 185).

Taken together, these indicators suggest strong U.S. inventive activity in advanced ceramics technology. While producing the second largest number of international patent families in this category during the period studied, U.S. inventions were the most highly cited and had nearly the highest average commercial potential when compared with inventive activity in the other five nations.

Summary

Based on this examination of international patenting, the U.S. S&T enterprise is producing inventions in important technologies that are able to be patented around the world. The U.S. lead in genetic engineering was most evident from this collection of international patenting indicators, but U.S. inventors also made a strong showing in robot technologies, especially in 1994.

³¹Operationally, this indicator included all families with priority application dates from 1990 to 1994 with four or more citations.

Text table 6-12. Advanced ceramics technology: International patent families, highly cited patent families, and citation ratios, by priority country: 1990-94

Priority country	Number of international families	Number of highly cited international families ^a	Country share of total (percent)	Country share of highly cited (percent)	Citation ratio ^b
Total	968	23.0	100.0	100.0	1.0
United States	310	15.0	32.0	65.2	2.0
Japan		4.0	39.4	17.4	0.4
Germany	151	1.0	15.6	4.3	0.3
France	69	1.0	7.1	4.3	0.6
United Kingdom	47	2.0	4.9	8.7	1.8
South Korea	10	0.0	1.0	0.0	0.0

^aAn international patent family was considered highly cited if the number of citations it received ranked it within the top 1 percent compared with all other advanced ceramics technology international patent families.

^bA citation ratio of greater than 1.0 indicates that a country has a higher share of highly cited international patent families than would be expected based on its share of total international families.

SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

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Text table 6-13.

Advanced ceramics technology:

Number of international patent families and average international family size: 1990-94

Priority country	Number of families	Average international family size	Adjusted average international family size ^a
France	69	11.2	1.9
United States	310	9.8	1.8
United Kingdom	. 47	11.6	1.7
Germany	. 151	9.7	1.7
Japan	. 381	5.3	1.6
South Korea	. 10	3.2	1.3

NOTE: Patent family size is determined by the number of countries for which patent protection is sought for a single invention.

^aPatent family data weighted by an index based on gross domestic product measured in purchasing power parities at current U.S. dollars of the patent country. This weighting adjusts family size for the size of the national markets in which protection is being sought in an effort to better reflect the commercial potential of the invention.

SOURCE: Derwent World Patents Index Database (London: Derwent Publications Ltd., 1996), special tabulations by Mogee Research & Analysis Associates under contract to the National Science Foundation.

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Venture Capital and High-Technology Enterprise

One of the most serious challenges to new entrepreneurs in the innovation process is capital—or the lack thereof. Venture capitalists typically make investments in small, young companies that may not have access to public or credit-oriented institutional funding. Venture capital investments can be long term and high risk, and may include hands-on involvement by the venture capitalist in the firm. Venture capital thus can aid the growth of promising small companies and facilitate the introduction of new products and technologies, and is an important source of funds used in the formation and expansion of small high-tech companies. This section examines venture capital disbursements by stage of financing and by technology area in the United States and Europe.

U.S. Venture Capital Industry

The pool of capital managed by venture capital firms grew dramatically during the 1980s as venture capital emerged as a truly important source of financing for small innovative firms. (See figure 6-23 and appendix table 6-19.) By 1989, the capital managed by venture capital firms totaled \$23.2 billion, up from an estimated \$3.0 billion in 1980. The number of venture capital firms also grew during the 1980s—from around 448 in 1983 to 670 in 1989.

In the early 1990s, the venture capital industry experienced a recession of sorts, as investor interest waned and the amount of venture capital disbursed to companies declined—especially compared to the extensive venture capital activity of the late 1980s. The number of firms managing venture capital also declined during the 1990s. But the slowdown was short-lived; investor interest picked up during 1992, and disbursements began to rise again. Both investor interest and venture capital disbursements have continued to grow through 1995. The latest data show total venture capital under management rising to \$37.2 billion in 1995, up from \$32.7 billion in 1994 and \$28.9 billion in 1993.

The number of venture capital firms in the United States did not rebound to the peak of 1989 (670), but after several

Figure 6-23. U.S. venture capital: Total under management, annual commitments, and disbursements Billions of U.S. dollars (log scale) 50 30 Total venture capital 20 under management 10 5 New commitments 3 2 1983 1985 1987 1989 1991 1993 1995 See appendix table 6-19. Science & Engineering Indicators - 1998

years of firm rationalization, the number rose to 610 venture capital firms in 1995 from the 591 operating in 1994. California, Massachusetts, and New York together account for nearly 65 percent of venture capital resources. The top 10 states account for over 95 percent. It appears that venture capital firms tend to cluster around locales considered to be "hotbeds" of technological activity, as well as in states where large amounts of R&D are performed.

Venture Capital Commitments and **Disbursements**

Several years of high returns on venture capital investments have stimulated increased investor interest. This interest soared from 1993 to 1995, with new commitments reaching \$4.2 billion in 1995, the largest one-year increase in venture capital funds. Pension funds remain the single largest source for new funds, supplying nearly 40 percent of committed capital. Endowments/foundations are the next largest source, supplying 23 percent of committed capital in 1995. (See appendix table 6-20.)

Starting in 1994, new capital raised exceeded capital disbursed by the venture capital industry, thereby creating surplus funds available for investments in new or expanding innovative firms. Thus far in the 1990s, firms producing computer software or providing computer-related services received the largest share of new disbursements. (See figure 6-24 and appendix table 6-21.) In 1991, software companies received 25 percent of all new venture capital disbursements, twice the share going to computer hardware companies and three times the share going to biotechnology companies. In 1995, software companies continued to attract the largest share of venture capital. Medical/health-care-related companies have

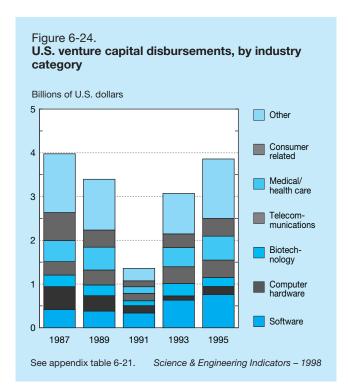
also attracted large amounts of venture capital during the 1990s, and edged out software companies for the lead in 1994. Other industries that received substantial amounts of venture capital in 1995 were telecommunications companies and consumer-related companies (e.g., leisure products, retailing, etc.).

Venture Capital Investments by Stage of Financing

The investments made by venture capital firms may be categorized by the stage at which the financing is provided:³²

- ◆ Seed financing—usually involves a small amount of capital provided to an inventor or entrepreneur to prove a concept. It may support product development but rarely is used for marketing.
- ♦ Startup financing—provides funds to companies for use in product development and initial marketing. This type of financing usually is provided to companies that are just getting organized or that have been in business just a short time but have not yet sold their product in the marketplace. Generally, such firms have already assembled key management, prepared a business plan, and made market studies.
- ◆ First-stage financing—provides funds to companies that have exhausted their initial capital and need funds to initiate commercial manufacturing and sales.
- ◆ Expansion financing—includes working capital for the initial expansion of a company, funds for either major

³²The financing stage definitions presented here are by Venture Economics (1996), appendix C.



growth expansion (involving plant expansion or marketing) or development of an improved product, and financing for a company expecting to go public within six months to a year.

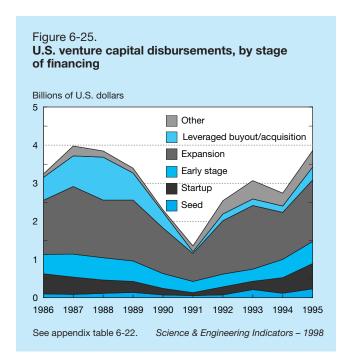
- ◆ Management/leveraged buyout financing—includes funds to enable operating management to acquire a product line or business from either a public or private company.
- ◆ Turnaround financing—provides financing to a company at a time of operational or financial difficulty, with the intention of turning the company around or improving its performance.

The first three may be referred to as early stage financing and the remaining three as later stage financing.

An examination of U.S. venture capital disbursements to companies since 1986 clearly shows that most of the funds are directed to later stage investments. Over the past 10 years, later stage investments captured between 62 and 76 percent of venture capital disbursements, with the high and low points both reached in the 1990s. (See figure 6-25 and appendix table 6-22.) Capital for company expansions attracted by far the most investor interest.

According to these data, very little venture capital goes to the struggling inventor or entrepreneur trying to prove a concept or to product development. Over the past 10 years, such seed money never accounted for more than 7 percent of all venture capital disbursements, and most often represented between 3 and 4 percent of the annual totals.³³

³³A study of new firms located in the Southwestern United States discovered that many of these firms were able to obtain substantial amounts of initial capital through strategic alliances with more established firms (Carayannis, Kassicieh, and Radosevich 1997). In that study, embryonic firms raised over \$2 million, on average, in early stage capital through such strategic alliances.



Europe's Venture Capital Industry

As in the United States, venture capitalists in Europe are attracted to young, small (under 500 employees), fast-growing companies in need of capital and management expertise. Europe now has venture-capital-backed investments all across the continent, including investments in many of the transitioning countries in Central and Eastern Europe. Data compiled by the European Venture Capital Association tracking venture capital activity in 17 countries record over 5,000 separate investments in 1996, with total disbursements exceeding \$8.5 billion—an 18 percent increase over 1995.³⁴ (See text table 6-14.) The United Kingdom leads Europe in both the number of venture-backed investments made and the amount invested in British companies during 1996 (33 percent and 44 percent, respectively). France, Germany, and the Netherlands follow, in that order. Together with the United Kingdom, they accounted for three-fourths of all European venture capital disbursed in 1996.

While computer-related and biotechnology companies in the United States garner the lion's share of U.S. venture capital, the types of firms attracting venture capital in Europe are less technology intensive. Europe has long held a reputation for excellence in industrial machinery and equipment, fashion, and leisure products (e.g., sporting goods). These same industries are among the top recipients of European venture capital. More than 30 percent of venture capital investments (both in number and as a percentage of the total capital distributed in 1995 and 1996) were made in companies providing industrial products such as machine tools, pollution and recycling equipment, and high-fashion clothing and other consumer products. By comparison, European computer-related companies received 7 percent of the venture capital distributed in 1995 and 5 percent in 1996. European biotech companies received even less attention, although both the number and size of the investments in this industry increased in 1996 over the previous year.

European venture capitalists, like their American counterparts, direct only a small portion of capital disbursements as seed money or startup capital. Investments for expanding an existing company's productive capacity, helping a company add a new product line, or enabling a company to acquire an existing business—later stage investments—account for about 85 percent of European venture capital disbursements. For the past five years (1992 to 1996), early stage investments (as seed or startup capital) stayed below 7 percent. In fact, seed money, often used to finance research or concept development, averaged less than 1 percent from 1992 to 1995; in 1996, startup capital for product development and initial marketing reached its highest point in five years, when it represented about 6 percent of venture capital disbursements. (See figure 6-26.)

³⁴Data reported on venture capital investments in Europe include management buyouts, management buyins, and other later stage investments not covered in the previous discussion on venture capital investment trends in the United States.

Text table 6-14.

Number and amount of European venture capital disbursements

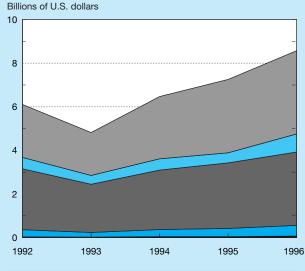
	199	5 investments	1996	3 investments
	Number	Millions of U.S. \$	Number	Millions of U.S. \$
European total	4,955	7,254.2	5,181	8,573.4
United Kingdom	1,716	3,443.0	1,715	3,774.0
France	994	1,113.1	1,186	1,078.0
Germany	762	871.1	769	907.9
Netherlands	280	610.8	320	752.0
taly	220	330.9	198	647.6
Sweden	78	112.5	172	533.3
Spain	218	213.2	158	245.1
Switzerland	29	62.8	32	161.3
Belgium	132	145.2	158	138.4
Norway	163	156.0	154	105.4
Finland	114	44.5	111	50.8
reland	33	24.9	65	48.3
Portugal	137	71.9	74	43.2
Denmark	48	40.5	38	43.2
Greece	13	10.5	23	40.6
Austria	4	1.3	4	1.3
celand	14	1.3	4	1.3

SOURCE: European Venture Capital Association, 1997 Yearbook (Zavenstem, Belgium: 1997).

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Figure 6-26.

European venture capital disbursements, by stage of financing





NOTE: The financing stages used to characterize European venture capital disbursements differ somewhat from the U.S. stages used. SOURCE: European Venture Capital Association, 1997 Yearbook

(Zavenstem, Belgium: 1997).

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New High-Tech Exporters

The previous sections identified several nations that have made tremendous technological leaps forward over the past decade. Some of these countries appear to be well-positioned to play even more important roles in technology development in the near future based on their often large and continuing investments both in science and engineering education and R&D. However, their level of participation may also hinge on other factors, among them political stability, access to capital, and the ability to complete a level of infrastructure that can support technological and economic advancement.

This section presents an assessment of future national competitiveness in high-technology industries for newly industrialized economies in Asia and in three transitioning economies—Hungary, Poland, and Russia. This competitiveness is gauged through scores on the following leading indicators:

- ◆ National orientation—evidence that a nation is taking directed action to achieve technological competitiveness. These actions might be explicit and/or implicit national strategies involving cooperation between the public and private sectors.
- ◆ Socioeconomic infrastructure—the social and economic institutions that support and maintain the physical, human, organizational, and economic resources essential to the functioning of a modern, technology-based industrial nation. Evidence of this type of infrastructure might be dynamic capital markets, upward trends in capital formation, rising levels of foreign investment, and national investments in education.

- ◆ Technological infrastructure—the social and economic institutions that contribute directly to a nation's capacity to develop, produce, and market new technology. Evidence of a supportive technological infrastructure might include the existence of a system for the protection of intellectual property rights, the extent to which R&D activities relate to industrial application, a nation's competency in high-tech manufacturing, and a nation's capability to produce qualified scientists and engineers from the general population.
- Productive capacity—the physical and human resources devoted to manufacturing products, and the efficiency with which those resources are used. A nation's productive capacity for future high-tech production can be assessed by examining its current level of high-tech production, including the quality and productivity of its labor force, the presence of skilled labor, and the existence of innovative management practices.

These four indicators were designed to identify countries that have the potential to become more important exporters of high-technology products over the next 15 years. This section analyzes 12 economies using these indicators: 9 within Asia (Singapore, South Korea, Taiwan, China, India, Indonesia, Malaysia, the Philippines, and Thailand); 2 Central European nations (Hungary and Poland); and Russia.³⁵

Because Singapore, South Korea, and Taiwan have already shown impressive capabilities as exporters of high-technology products, they are often referred to as newly industrialized economies. The six remaining Asian economies are less developed technologically and are considered emerging Asian economies in this section. The three Central and Eastern European nations—Hungary, Poland, and Russia—are actively pursuing market-based reforms and are collectively referred to as transitioning economies. For this model of indicators, the Asian newly industrialized economies become the benchmark to compare expectations and technological capabilities for the other nine.³⁶

National Orientation

The national orientation indicator attempts to identify those nations whose business, government, and cultural orientation encourage high-technology development. This indicator was constructed using information from a survey of international experts and published data. The survey asked the experts to rate national strategies promoting high-tech development, social influences favoring technological change, and entrepreneurial spirit. Published data were used to rate each nation's risk factor for foreign investment over the next five years (see Frost and Sullivan 1996).

The newly industrialized Asian economies posted the highest overall scores on this indicator, with Taiwan just edging out Singapore. (See figure 6-27 and appendix table 6-23.) Entrepreneurial spirit was rated much higher for Taiwan than for Singapore. This rating, derived from expert opinion, elevated Taiwan's overall score above Singapore's—despite Taiwan scoring lower than Singapore on each of the other components. While South Korea scored lower than the other two Asian "tigers" on each of the components that make up this indicator, its composite score was largely compromised by its rating as a riskier place for foreign investment than either Taiwan or Singapore.

Malaysia's national orientation toward achieving future technological competitiveness was rated far above the other emerging Asian economies and the transitioning economies in Central Europe and Russia. Across the full range of variables considered, Malaysia's scores were consistently and significantly higher than the other countries in this second group and were well within the range of scores accorded the more advanced newly industrialized Asian economies. The Philippines also scored well, with strong scores in each of the indicator components, elevating it to the second highest score among the emerging Asian economies and other transitioning economies in Central Europe.

Scores tended to converge for the remaining Asian and Central European economies, although each country's composite score is built on different strengths. Scores for Poland and Hungary were slightly higher than those for China and Thailand. Published data rated the two Central European nations a better risk for foreign investment than China, and the surveyed experts gave an edge to Poland and Hungary over Thailand on "entrepreneurial spirit."

Russia received the lowest composite score of the 12 economies examined. Two variables contributed to this standing: Russia was considered a riskier or less attractive site for foreign investment than the other countries, and the experts accorded Russia a low score on its entrepreneurial spirit.

Socioeconomic Infrastructure

This indicator assesses the underlying physical, financial, and human resources needed to support modern technology-based nations. It was built from published data on population percentages in secondary schools and in schools of higher education³⁷ and from survey data evaluating the mobility of capital and the extent to which foreign businesses are encouraged to invest and/or do business in that country.

Taiwan and Singapore are in a virtual tie and once again received the highest scores among the group of newly industrialized and emerging economies. In addition to strong track records on general and higher education, Taiwan and

³⁵See Porter and Roessner (1991) for details on survey and indicator construction; see Roessner, Porter, and Xu (1992) for information on the validity and reliability testing the indicators have undergone.

³⁶Although not discussed in this section, indicator scores for Argentina, Brazil, Mexico, Venezuela, and South Africa are presented in appendix table 6-23

³⁷The Harbison-Myers Skills Index (which measures the percentage of population attaining secondary and higher educations) was used for these assessments. See World Bank (1996).

Figure 6-27. Leading indicators of technological competitiveness: 1996 **National orientation** Singapore 88.4 South Korea 78.9 Taiwan 190.2 China 65.3 57.4 India Indonesia 54.8 Malaysia 81 **Philippines** 73.6 Thailand 63.5 Hungary 67 Poland 69.7 Russia Socioeconomic infrastructure Singapore 75.7 South Korea 64.6 Taiwan 75.8 China 44.8 India 46.0 35.2 Indonesia Malaysia 62.5 **Philippines** 66.2 Thailand 48.7 Hungary 47.7 Poland 157.4 Russia 50.7 Technological infrastructure Singapore 41.6 South Korea 44.4 Taiwan 42.9 China 39.3 India 39.3 Indonesia 17.8 Malaysia **1**31.9 **Philippines** 35.3 Thailand 28.2 Hungary 36.4 38.1 Poland Russia 55.6 Productive capacity Singapore 54.0 South Korea 50.6 Taiwan 49.9 China 32.8 India 49.1 Indonesia 19.6 43.1 Malavsia Philippines 48.1 33.1 Thailand Hungary 39.8 Poland 39.8 Russia 42.6 0 80 100 20 40 60 Index NOTE: Scores were normalized to median values of zero based on raw scores for 30 countries included in the study. See appendix table 6-23. Science & Engineering Indicators - 1998

Singapore reflect high expert ratings for variables comparing the mobility of capital and for their encouragement of foreign investment. (See figure 6-27.) South Korea's overall indicator score trailed these two leaders, especially with regard to the two expert-derived variables.

Among the emerging and transitioning economies, the Philippines once again scored surprisingly well, outscoring even Malaysia. The rating for the Philippine socioeconomic infrastructure was bolstered by a stronger showing in the published education data and in the experts' higher opinion of mobility of capital in the Philippines.

Indonesia received the lowest composite score of the 12 economies examined. It was held back by low marks on two of the three variables: educational attainment—in particular, enrollments in tertiary education—and its encouragement of foreign-owned business and investment.

Technological Infrastructure

Five variables were used to develop this indicator, which evaluates the institutions and resources that contribute to a nation's capacity to develop, produce, and market new technology. This indicator was constructed using published data on the number of scientists in R&D; published data on national purchases of electronic data processing equipment; and survey data that asked experts to rate the nation's capability to train citizens locally in academic S&E, the ability to make effective use of technical knowledge, and the linkages of R&D to industry.

Russia received the highest composite score of the group of newly industrialized or transitioning economies examined here. (See figure 6-27.) Russia's score on this indicator was elevated by its large number of trained scientists and engineers, the size of its research enterprise, and its contribution to scientific knowledge—especially as compared with the smaller, less populous nations in Asia and Central Europe. Russia's composite score was more similar to mid-level Western European scores on this indicator. (See appendix table 6-23.) Poland also scored well, bolstered more by experts' rating of the quality of that country's scientists and engineers and its capacity to train new scientists and engineers, rather than on the sheer number of those professionals residing within the country.

The three Asian tigers—Singapore, South Korea, and Taiwan—compiled similar scores. Singapore scored relatively well vis-à-vis the other Asian tigers, given its small population.

The population effect shows up again in the scores of the remaining countries analyzed here. China and India both scored well, leading the other emerging and transitioning economies. Indonesia's large population, however, did not save it from the bottom ranking. It earned low scores on each of the variables making up this indicator.

Productive Capacity

This indicator evaluates the strength of a nation's current, in-place manufacturing infrastructure as a baseline for assessing its capacity for future growth in high-tech activities. It factors in expert opinion on the availability of skilled labor, numbers of indigenous high-tech companies, and management capabilities, combined with published data on current electronics production in each economy.

Singapore's productive capacity scored highest among the three Asian tigers, surpassing South Korea and Taiwan by virtue of experts' high opinion of this country's pool of labor and management personnel. (See figure 6-27.) India and the Philippines both scored quite high—in fact, their composite scores were closer to Taiwan's than to any in the group of emerging or transitioning economies. India's score was elevated by its comparatively large electronics manufacturing industry and—once again—by its tradition of training its students in science and engineering. The Philippines' score also stands out. As with Singapore, experts gave high marks to the pool of skilled labor and management talent in the Philippines. That country's scores were on a par with those received by the three Asian tigers. Although Indonesia's score for production of electronics products—this indicator's published data variable—was between that of India and the Philippines, its scores from experts rating the quality of labor and management were very low.

This model of indicators provides a systematic approach for comparing future technological capability on an even wider set of nations than might be available using other indicators. The results highlight a broadening of the group of nations that may compete in high-tech markets in the future, while also giving perspective to the large differences between several of the emerging and transitioning economies and those considered newly industrialized.

Summary: Assessment of U.S. Technological Competitiveness

This chapter brings together a collection of indicators that contrast and compare national technological competitiveness across a broad range of important technological areas. Based on the various indicators of technology development and market competitiveness examined, the United States continues to lead or be among the leaders in all technology areas. Advancements in information technologies (computers and telecommunications products) continue to influence new technology development and to dominate technical exchanges between the United States and its trading partners.

Asia's status as both a consumer and developer of hightech products has been enhanced by the technological development taking place in the newly industrialized Asian economies—in particular, Taiwan and South Korea—and in emerging and transitioning economies such as Malaysia, China, and the Philippines. Asia's influence in the marketplace seems likely to expand in the future as other technologically emerging Asian nations join Japan as both technology producers and consumers.

Recently, several Asian nations have faced turmoil in their banking systems and capital markets. It is unclear how these developments will affect Asian economies and S&T capabilities.

The current strong position of the United States as the world's leading producer of high-tech products reflects its success both in supplying a large home-based market as well as in serving foreign markets. In addition to the nation's long commitment to investments in science and technology, this success in the international marketplace may be in part a function of scale effects derived from serving this large, demanding domestic market; it may be further aided by the U.S. market's openness to foreign competition. In the years ahead, these same market dynamics may also benefit a more unified Europe and/or a rapidly developing Asia and complement their investments in science and technology.

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Chapter 7 Science and Technology: Public Attitudes and Public Understanding

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Highlights

INTEREST IN SCIENCE AND TECHNOLOGY

- ♦ American adults express a high level of interest in new scientific discoveries and in the use of new inventions and technologies. This level of interest has remained high for more than two decades and reached a new high point in 1997. Individuals with more years of formal education and more courses in science and mathematics are more likely to indicate a high level of interest in science and technology.
- ♦ About one in five Americans think that they are very well-informed about new scientific discoveries and about the use of new inventions and technologies. Americans with more years of formal education and more courses in science and mathematics are significantly more likely to view themselves as very well-informed than others. Men are significantly more likely to indicate that they are very well-informed about science and technology, holding constant the level of formal education and the level of science and mathematics education.

UNDERSTANDING BASIC SCIENTIFIC AND TECHNICAL CONCEPTS

- ♦ There is a wide distribution in the level of measured understanding of scientific terms and concepts among American adults. On a 0-100 scale, the mean score was 55. This score has remained relatively constant since 1988. Individuals with more years of formal schooling and more courses in science and mathematics obtained significantly higher scores, demonstrating the pervasive effect of science and mathematics education throughout the adult years.
- ♦ One-quarter of Americans understands the nature of scientific inquiry well enough to be able to make informed judgments about the scientific basis of results reported in the media. Public understanding of the nature of scientific inquiry was measured through questions concerning the meaning of scientific study and the reasons for the use of control groups in experiments. Individuals who have completed more years of formal schooling and more courses in science and mathematics were significantly more likely to understand the nature of scientific inquiry than other citizens.

♦ The mean score of American adults on an indicator of understanding of basic scientific concepts was tied for first with Denmark, followed closely by the Netherlands and Great Britain; it was higher than the mean scores of adults in Germany, Canada, Japan, Italy, and six other European industrial nations. This result is in sharp contrast to results produced by American students in the Third International Mathematics and Science Study.

ATTENTIVE PUBLIC FOR SCIENCE AND TECHNOLOGY ISSUES

♦ Approximately 27 million Americans—14 percent are attentive to science and technology policy issues, a level that has increased in recent years. In complex modern societies, it is not possible for citizens to become and remain informed about the full range of public policy areas. Some degree of issue specialization is inherent in industrial societies.

Sources of Scientific and Technical Information

- ♦ Americans receive most of their information about public policy issues from television news programs and newspapers. When placed on a uniform metric of the number of uses or hours per year, the public consumption of television news and newspapers dwarfs all other information sources. In 1997, Americans watched an average of 432 hours of television news and read 196 newspapers in a 12-month period. During this same period, Americans watched 72 hours of science shows on television. Individuals with cable or satellite TV service watch more science television programs than people without this service.
- ♦ Fifty-seven percent of Americans use a computer at home or at work. Computer use has increased steadily during the last decade. In 1997, a typical American used a computer at work for an average of 369 hours and used a home computer for an additional 130 hours. A significantly higher proportion of college graduates use a computer than of individuals with fewer years of schooling.
- ◆ In 1997, an estimated 11 percent of Americans lived in a household with more than one working computer. In contrast, only 8 percent of Americans had any access to a home computer in 1983.

- ♦ Nearly 32 million Americans have a home computer that includes a modem, and 18 percent of adults reported in 1997 that they had used an on-line computer service during the preceding year. This is a significant increase in home access to on-line resources since 1995. In 1997, 29 percent of adults in the United States reported having a home computer with a CD-ROM reader, opening additional information acquisition opportunities. Nearly two-thirds of Americans with a graduate or professional degree have a home computer with a modem, compared to 31 percent of those with a high school degree. Similarly, 41 percent of Americans with a graduate degree reported that they use an on-line computer service, compared to only 17 percent of high school graduates.
- ♦ Twelve percent of adults—approximately 22 million people—indicated that they had previously tried to find some specific items of information on the Web. This pattern of response indicates that people are using the Web as they might use reference materials in a library. An analysis indicated that approximately 6.5 million Americans had attempted to find some information on the Web about a specific health condition or problem, and approximately 8.8 million had tried to find some scientific information on the Web—including information on the space program, environmental information, and computer information.

ATTITUDES TOWARD SCIENCE AND TECHNOLOGY

- ♦ Americans continue to hold the scientific community in high regard. According to the most recent General Social Survey, approximately 40 percent of Americans have a great deal of confidence in the leadership of the scientific community and in the leadership of the medical community. These levels of national esteem have been stable for nearly two decades and are far higher than the levels reported for the leadership of other major institutions in society.
- ♦ Americans hold positive attitudes toward science and technology and have high expectations for future benefits from science. When two sets of attitude questions were converted into 0-100 scales reflecting the *promise of*

- science and reservations about science, Americans posted a mean score of 70 on the Index of Scientific Promise and 37 on the Index of Scientific Reservations. This level of reservation is the lowest reported by citizens in major industrial nations. On a separate measure that asked citizens to assess the relative benefits and potential harms from scientific research, 75 percent of Americans believe that he benefits of scientific research outweigh any present or potential harms. This level of positive assessment of scientific research has been stable for four decades and is consistent with the high esteem noted above. College graduates and citizens attentive to science and technology policy hold even more positive views of science.
- ♦ Despite their positive views of scientific research, Americans are deeply divided over the development and impact of several important technologies: nuclear power, genetic engineering, and space exploration. For more than a decade, Americans have been evenly divided on the benefits and harms of using nuclear power to generate electricity. A similar division exists over the benefits and potential harms of genetic engineering, but there is a clearer difference by level of education. College graduates hold a much more positive view of genetic modification research. The general public is evenly divided over the relative benefits and costs of the space program. College graduates and those who are attentive to space exploration remain very positive toward the program.
- ♦ Nearly 80 percent of Americans agree that the Federal Government should support basic scientific research that advances the frontiers of knowledge even when it does not provide any immediate benefits. Asked of national samples of American adults since 1985, total public approval of government support of basic scientific research has remained constant at about 80 percent throughout the last decade. During the same time period, approximately 90 percent of Americans with a baccalaureate degree voiced approval for government support of basic scientific research.

Introduction

Chapter Overview

Science and technology have become integral components of the American culture. Over 85 percent of Americans believe that the world is better off due to science, and this level of general support has continued over the last four decades. Americans believe that scientists and engineers can cure diseases, explore space, and develop ever faster modes of communication. The growth of interest in science and technology is reflected in extensive use of informal science learning resources, from television to the World Wide Web. Paradoxically, this pattern of high expectation for science and technology is not matched by a comparable level of understanding of the scientific process or of basic scientific concepts.

In a democratic society such as the United States, it is important to understand attitudes about scientific and technological issues. Over the last two decades, the *Science & Engineering Indicators* studies have built a comprehensive database that helps to illuminate patterns of change. It is equally important to apply current social science theory to the understanding and interpretation of these data. A series of analyses describes the structure and patterns of change and stability in public attitudes toward science and technology.

Today, the means of communication change as rapidly as the substance of science and technology. It is important for the scientific community to communicate with the public about the promise and needs of science. To do so requires an understanding of the sources of information that people use and of which people use each of the various kinds of media for communication.

Chapter Organization

This chapter begins with a discussion of the level of public interest in selected areas of science and technology, and examines changes in the patterns of public interest in these issues over the last two decades.¹ The level of interest in

¹Twelve of the 13 *Indicators* volumes published since 1972 have included a chapter on public attitudes toward and understanding of science and technology. The studies for the 1972, 1974, and 1976 Indicators were based on a block of 20 items inserted into an omnibus national personal interview survey conducted by Opinion Research Corporation of Princeton, New Jersey. The 1979 study was designed by Miller and Prewitt (1979) and analyzed by Miller, Prewitt, and Pearson (1980); the personal interviews were conducted by the Institute for Survey Research at Temple University. Additional national studies were supported by the 1982, 1985, 1987, 1991, and 1993 Indicators reports, with telephone interviews conducted by the Public Opinion Laboratory at Northern Illinois University. The chapter for Science Indicators 1985 was based on a national telephone study conducted by the Public Opinion Laboratory for Professor George Gerbner of the Annenberg School of Communication at the University of Pennsylvania. In 1995 and 1997, the Chicago Academy of Sciences conducted studies that continued the core of attitude and knowledge items from previous Indicators studies and included telephone interviews with a random-digit sample of 2,006 adults in 1995 and 2,000 in 1997. The interviews for the 1995 study were conducted by the Public Affairs Division of Market Facts Incorporated. The interviews for the 1997 study were conducted by the National Opinion Research Center. The results can be found in past volumes of *Indicators* (NSB biennial series). The data from these studies are available for secondary analysis from the International Center for the Advancement of Scientific Literacy at the Chicago Academy of Sciences.

science and technology issues is an indicator of both the visibility of the work of the scientific community and of the relative importance accorded science and technology by society.

The second section of this chapter examines the level of public understanding of basic scientific concepts and the nature of scientific inquiry, looking at patterns of change over the last decade. The level of public understanding of basic scientific terms and concepts is compared for 14 leading industrial nations.

The third section of the chapter examines two sets of general, or filtering, attitudes toward science and technology. One filter reflects an individual's belief in the promise of science and technology to improve the quality of life, while another reflects the level of concern or reservation about possible negative impacts from science or technology. General attitudes in the United States and 13 other industrial nations are compared.

The fourth section analyzes the linkage between these general attitudinal filters and the policy preferences of citizens regarding government spending for basic scientific research. The development of these structural relationships over the last decade in the United States is examined, and the patterns found in the United States are compared with those for 13 other industrial nations.

The fifth section analyzes the sources of information used by citizens to improve and maintain their understanding of scientific and technical issues. This analysis examines the growth of computer access and use in the United States. New information is provided about access to electronic networks and the purposes for which individuals use the Internet.

The final section summarizes the results described in this chapter and discusses some of their major implications.

Interest in Science and Technology

Citizens of modern industrial societies like the United States live in the midst of a wide array of technologies—old and new. Most Americans now use a computer at home or work, drive automobiles controlled by computer chips, watch weather reports with satellite images only hours old, and take pharmaceuticals based on new biotechnologies unknown a decade ago. The media carry frequent reports of the results of scientific research, with a strong emphasis on biomedical research and results. The recent landing on Mars of an explorer that is essentially operated from the earth, and live coverage of the vehicle's movements and preliminary findings symbolize the interesting mix of technology and science experienced by the public.

Modern science and technology are only a part of the daily array of interesting and important news events. As interesting as science and technology may be to scientists and others knowledgeable about their activities, among the general public they compete with the demands of family and work, and many entertainment and educational opportunities. Individuals in modern industrial societies have to make choices

about how they spend their time, the issues that they will attend to (if any), and the level of participation they will devote to them.

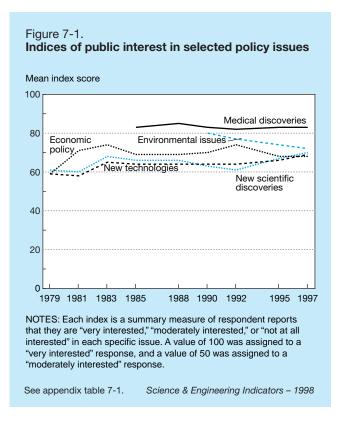
Interest in Science and Technology Issues

The level of interest in science and technology in the United States has remained high during the last two decades, reaching a new high point in 1997. Using a 0-100 Index of Issue Interest, the mean level of public interest in new scientific discoveries has risen from 61 in 1979 to 70 in 1997. (See figure 7-1 and appendix tables 7-1, 7-2, and 7-3.) In a parallel pattern, public interest in issues concerning the use of new inventions and technologies has grown from 59 in 1979 to 69 in 1997. Interest in medical discoveries has remained high throughout the last decade. There is some evidence that interest in environmental issues has declined slightly. In the early 1990s, interest in environmental issues was comparable to the level of interest in medical discoveries; by 1997, interest in environmental issues was about the same as interest in economic policy issues.

The level of interest in a particular issue area reflects both a core group of citizens with a long-term interest in that particular issue, plus some citizens who become more interested due to short-term policy disputes or activities. The nearly two decades of data collected by the Science & Engineering *Indicators* program demonstrate several of these patterns. The incoming Reagan Administration focused substantial attention on a reexamination of economic policies in the early 1980s, leading to a series of major disputes with Congress. These policy differences and the extensive media coverage of the debate were reflected in a substantial increase in the levels of public interest in economic issues and business conditions from 1979 to 1981, with additional growth of interest in 1993. The current Administration has emphasized the need for a strong scientific base for the United States and has focused attention on the World Wide Web and on increasing student access to computers in elementary and secondary schools.

Individuals with higher levels of formal education and more high school and college coursework in science and mathematics were significantly more likely to register higher levels of interest in new scientific discoveries, the use of new inventions and technologies, and space exploration than other citizens. (See figure 7-2 and appendix table 7-3.) In contrast, individuals with higher levels of formal education expressed only a slightly higher interest score for medical discoveries, nuclear power, and environmental issues than other adults.

In 1997, men were more likely than women to indicate a high level of interest in the use of new inventions and technologies, and space exploration. Women were more likely to express a high level of interest in medical discoveries and environmental issues than men.

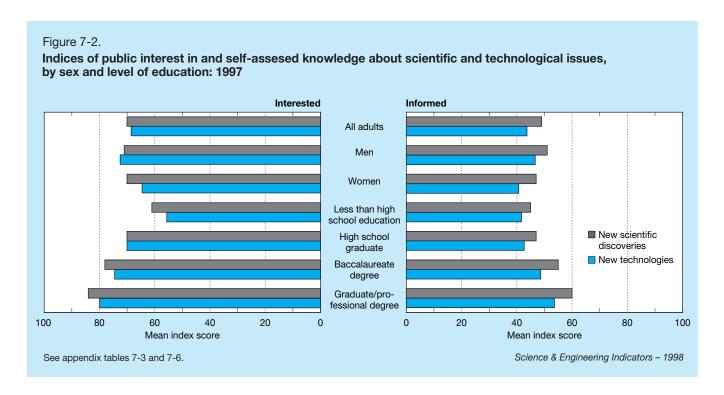


Informedness About Science and Technology Issues

In contrast to the levels of interest reported above, American citizens report lower levels of information about these same issues. Nevertheless, the levels of informedness about selected scientific issues have risen over the past two decades. Using a 0-100 Index of Issue Informedness,² the mean level of informedness about new scientific discoveries has increased from 36 in 1979 to 49 in 1997. Informedness about new inventions and technologies experienced a similar increase—from 35 in 1979 to 44 in 1997. (See figure 7-3 and appendix tables 7-4, 7-5, and 7-6.) Throughout the last decade, the public reported the highest recorded mean level of informedness about medical discoveries.

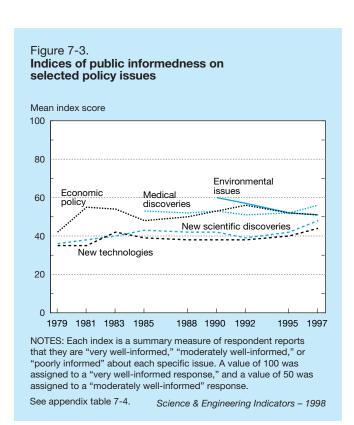
It is important to understand how individuals assess their own knowledge of these subjects. For many purposes—from deciding which cleaning product will be most effective to writing a legislator on a current issue—it is the individual's self-assessment of his or her knowledge that will either encourage or discourage a given behavior (Rosenau 1974, Miller 1983a, and Miller 1996b). Only 16 percent of American adults think of themselves as

²"Informedness" is a useful short-hand term to denote an individual's self-assessment of his or her level of understanding of a particular issue area. The Index of Issue Informedness is a summary measure reflecting each individual's self-assessment as "very well-informed," "moderately well-informed," or "poorly informed" on a specific issue. A score of 100 points was assigned to a "very well-informed" response, and a score of 50 points was assigned to a "moderately well-informed" response. "Poorly informed" responses received a score of 0 points. The index score is the mean value of the responses for any year or group.



being very well-informed about space exploration, and only 10 percent think they are very well-informed about the use of nuclear power to generate electricity.

Comparatively, 28 percent of American adults feel that they are very well-informed about medical discoveries, and 23 percent reported that they are very well-informed about



environmental issues. Medical concerns and issues tend to affect daily life for more people than issues such as nuclear power or space exploration, and it is not surprising that there is a more pervasive sense of being better informed about more personal issues than more distant ones. Similarly, individuals who can see the air pollution around major cities or who have to modify their plans due to ozone alerts or polluted beaches may feel better informed about environmental issues than about more distant topics.

The influence of formal education and prior coursework in science and mathematics on most individuals' perception of their understanding about scientific and technical issues is substantial. In 1997, for example, individuals who did not graduate from high school had a mean score of 42 on informedness about the use of new inventions and technologies, compared to 54 for graduate degree-holders. (See figure 7-2 and appendix table 7-6.) In contrast, adults who did not complete high school had a mean score of 58 for informedness about medical discoveries, compared to 61 for graduate degree-holders.

Although the levels of self-reported understanding are significantly lower than the levels of interest in the same issues, the levels of self-perceived understanding are increasing. The sense of being very well-informed about new scientific discoveries increased from 13 percent in 1995 to 19 percent in 1997. Similarly, the sense of being very well-informed about the use of new inventions and technologies increased from 12 percent in 1995 to 16 percent in 1997. As discussed later in this chapter, this rise in self-perceived understanding parallels an increase in the use of science-related media and informal educational resources.

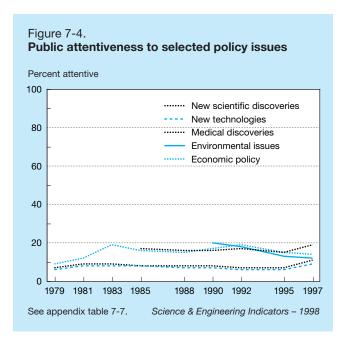
Attentiveness to Science and Technology Issues

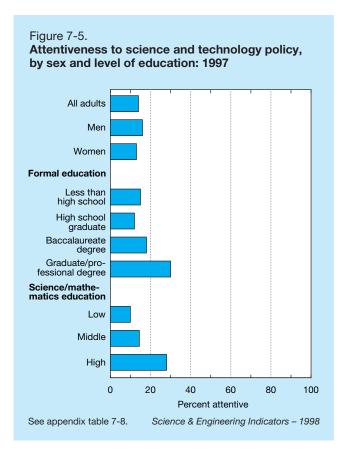
Given the large number of issues on the public policy agenda at any point in time, it is impossible for citizens to remain interested in and informed about all public policy matters. In a pluralistic society like the United States, some individuals may follow agricultural issues and foreign policy issues closely, but have little interest in science or technology issues. Other citizens may have a high level of interest in science and technology policy issues as well as foreign policy issues, but no interest in agricultural issues. All citizens, including virtually all legislators, must be selective regarding the areas and issues about which they seek to be sufficiently informed to participate in policy discussions. This process of issue specialization is a fact of political life in modern industrial societies.

Citizens who display a high level of interest in an issue area, who feel well-informed about it, and who show at least a minimal pattern of information acquisition are classified as *attentive* to that issue.³ A citizen with a high level of interest in a particular issue, but who does not feel well-informed about it, is classified as a member of the *interested* public for that issue. Citizens without a high level of interest in a specific issue are referred to as the *residual* public for that issue area. There is an attentive public for every major public policy area; these publics differ in size and composition.

Reflecting the increased sense of informedness noted above, the percentage of American adults attentive to science and technology policy increased over the past decade, rising from 11 percent in 1988 to 14 percent in 1997. This attentive public includes approximately 27 million American adults and is the same size as the attentive public for economic policy. By comparison, 19 percent of Americans were attentive to medical discoveries in 1997, but only 12 percent were attentive to environmental issues. Only 5 percent of American adults were attentive to foreign policy and 4 percent to nuclear power issues. (See figure 7-4 and appendix table 7-7.)

There is a direct correlation between attentiveness to science and technology policy issues and years of formal schooling and the number of science and mathematics courses taken during high school and college. (See figure 7-5 and appendix table 7-8.) Only 15 percent of individuals with less than a high school diploma are attentive to science and technology policy issues, compared to 30 percent of graduate and professional degree-holders. Similarly, 10 percent of those with limited coursework in science and mathematics were attentive to science and technology policy issues, compared to 28 percent of those





with nine or more high school or college science or math courses. Men were slightly more likely to be attentive to science and technology policy issues than women, but the magnitude of this difference was smaller in 1997 than in previous years.

³A minimal pattern of information acquisition consists of either reading a newspaper on a daily basis or reading a weekly or monthly magazine relevant to the issue area. For a general discussion of the concept of issue attentiveness, see Almond (1950); Rosenau (1974); Miller (1983a); and Miller, Pardo, and Niwa (1997).

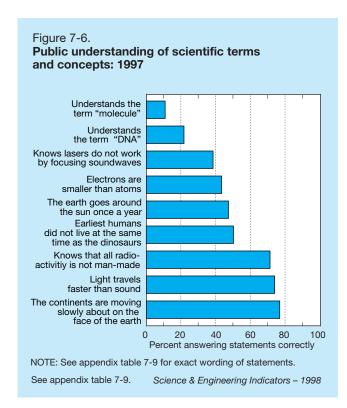
Understanding of Scientific and Technical Concepts

The modern citizen lives in a sea of words. The daily newspaper includes thousands of words to attract interest. Television news adds pictures and color, but requires accompanying spoken words to be enlightening. Increasingly, headlines, news stories, telecasts, magazine articles, and instruction manuals use a vocabulary of scientific terms and concepts, often assuming that most readers or viewers will understand them. This section looks at the level of public understanding of science and technology concepts.

Understanding of Basic Concepts

An understanding of a basic set of scientific concepts is an important prerequisite for understanding discussions of science and technology, and for participating in the process of formulating science and technology policy. While the range of possible scientific terms or concepts is large, it is possible to identify a sample of items that concern the composition of matter, the nature of the universe, the basic processes that have shaped our planet, and the basic biology that supports life. A set of nine knowledge items can be used to estimate the level of scientific construct understanding in the United States over the last decade.

Looking at the level of understanding on the individual items, it appears that only 11 percent of Americans can define the term "molecule." (See figure 7-6 and appendix table 7-9.) A large proportion of the population knows that a molecule is a small piece of matter, but is unable to relate it to an atom or a cell, which are also small pieces of matter.



One in five Americans was able to provide a minimally acceptable definition of DNA. And, despite substantial media attention to deep space probes and pictures from the Hubble Space Telescope, only 48 percent of Americans know that the earth goes around the sun once each year.

On the positive side, 78 percent of Americans recognize that portions of the earth's crust—thought of in terms of continents—have been moving for millions of years and will continue to move in the future, and 75 percent know that light travels faster than sound. About 71 percent of American adults reject the idea that all radioactivity is man-made. Despite this promising level of understanding of these basic physical and geological concepts, only 39 percent of American adults disagreed with the statement that "lasers work by focusing soundwaves." Perhaps reflecting the legacy of Fred Flintstone, only half of Americans rejected the statement that "the earliest humans lived at the same time as the dinosaurs."

Using the same testing technology used in many national and international tests, the responses to these nine items were converted into a 0-100 scale.⁴ The mean score for American adults on the Index of Scientific Construct Understanding was 55, the same as in 1995 and comparable to 1988 and 1990 index scores. (See figures 7-7 and 7-8 and appendix table 7-10.) Understanding of scientific constructs was strongly related to both the level of formal education and the number of high school and college science and mathematics courses taken. The mean score for college graduates was 68, compared to 44 for individuals who did not complete high school. Individuals who completed nine or more high school and college science or math courses had a mean score of 74, compared to 47 for adults who had five or fewer courses.

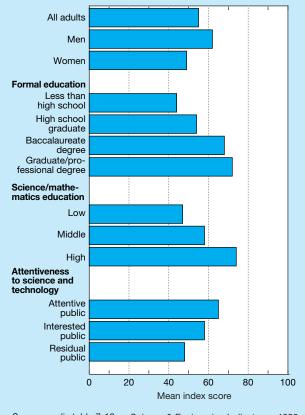
Men scored significantly higher than women, with a mean score of 62 compared to 49 for women. (See figure 7-7 and appendix table 7-10.) The scores partly reflect differences in coursetaking patterns, with men traditionally taking more science and mathematics courses than women. Several studies from the last decade indicate that this coursetaking gap has been nearly eliminated in mathematics and in science.⁵

⁴The items included on the construct vocabulary dimension were first identified by a confirmatory factor analysis. To place these items on a common metric that would be applicable to studies in the United States and to studies conducted in other countries, a set of item-response theory (IRT) values were computed for each item which takes into account the relative difficulty of each item and the number of items used in each study. This technique has been used by the Educational Testing Service and other national testing organizations in tests such as the Test of English as a Foreign Language (TOEFL), the computer-based versions of the Graduate Record Examination (GRE), and the National Assessment of Educational Progress (NAEP). The original IRT score for each respondent is computed with a mean of 0 and a standard deviation of 1, which means that half of the respondents would have a negative score. To put the result in more understandable terms, the original IRT score was converted to a 0-100 scale. See Zimowski et al. (1996) for a more complete discussion of item response theory. For more information on confirmatory factor analysis, see Long (1983) or Loehlin (1987).

⁵See Legum et al. (1993), Matti et al. (1994), and NCES (1997) for a more complete discussion of changes in mathematics and science coursetaking by sex.

Figure 7-7.

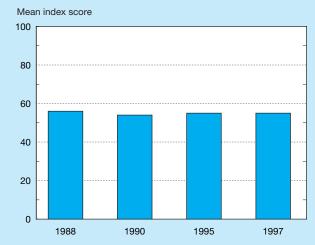
Mean score on Index of Scientific Construct
Understanding, by sex, level of education, and
attentiveness to science and technology: 1997



See appendix table 7-10. Science & Engineering Indicators – 1998

Figure 7-8.

Mean score on Index of
Scientific Construct Understanding



SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Science & Engineering Indicators – 1998

Understanding of Scientific Inquiry

To handle the daily flow of news reports about scientific and medical findings, citizens must understand the nature of scientific inquiry. A major difficulty in measuring the public understanding of scientific inquiry is that science does not utilize a single uniform procedure. While some sciences rely heavily on experimental procedures, others depend primarily on observation, measurement, and model building and testing. Other sciences depend heavily on fossil discovery, classification, and the construction or integration of possible developmental sequences. Virtually all of these approaches are utilized to some degree under the broad umbrella of scientific inquiry.

What is central to all scientific endeavor, however, is the effort to build theories or models to enhance our understanding of nature and the materials and processes found in nature. Parallel to the theory-building process is a commitment that all theories must be subject to logical or empirical falsification. Thus, the first level of conceptualization of science is an activity for the purpose of building and testing theory.⁶

At a second level, some individuals think of all scientific inquiry as a form of experimental investigation. This may reflect an understanding that scientific ideas are subject to testing. Popper's concept of falsification is not widely known (Popper 1959), and most people still think that scientists prove their theories or ideas much as a mathematician might "prove" a theorem. Thus, a second important level of public understanding of scientific inquiry involves the view of science as the conduct of experimentation. This view is reinforced by frequent media reports of medical and pharmaceutical trials of new procedures or products.

At a third level, some people simply think of science as rigorous comparison. This view of science is largely devoid of any notion of theory building. It lacks understanding of experimentation as the use of random assignment and control groups, or of the purposes for those procedures. It does view science as empirical in character, often perceiving science as "testing," as against some known standard.

This duality of meaning creates an interesting measurement problem. When a respondent is asked, for example, what it means to study something scientifically, and responds that it has to do with "making theories and things," it is not clear whether the individual means to use theory in a Kuhnian (Kuhn 1962) sense or as an unsupported speculation. For this reason, it is important to ask these questions in an open-ended format and to probe the responses.

⁶While there is broad consensus that theory building is the primary objective of science, this level of conceptualization is relatively rare in the public and not universal among graduates of science, engineering, or medical programs. The measurement of the understanding of scientific inquiry at this level is compounded by the dual meaning of "theory" in American English. In the usage employed above, "theory" refers to comprehensive sets of statements about the operation of various aspects of nature, or the development of models of natural processes. This usage would apply to generalizations or models in the biological, social, or physical sciences. At the same time, "theory" is often used in everyday language to refer to speculations or suppositions not yet supported by evidence. For example, it is common to hear a person dismiss a speculation by another person by saying that it is "only a theory," meaning that there is no evidence, or insufficient evidence, for that conclusion. Ironically, this is almost exactly the opposite meaning of the term as used in science.

Below these levels of conceptualization, many individuals have some awareness of the word "science," but no cognitive substance behind the word. It may be associated with precise measurement or with good or bad outcomes (medical miracles or weapons of mass destruction), but the work of scientists and the process of scientific inquiry are not understood. Most of these individuals hold positive attitudes toward science, and expect it to cure most diseases and to solve environmental problems. There is, however, a higher level of reservation among these individuals, which may reflect their recognition of the enormous power of science and technology and their inability to understand it.

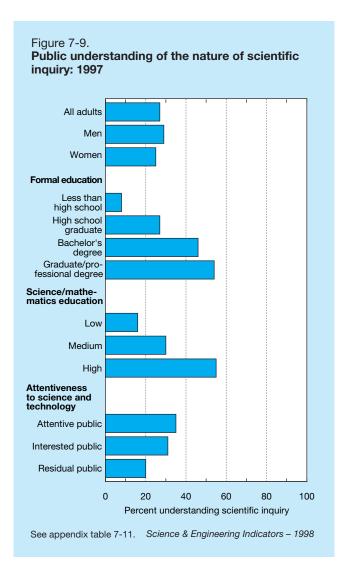
To find out how well the public understands the nature of scientific inquiry, adults have been surveyed in a series of *Science & Engineering Indicators* studies over the last decade. They were asked to define the meaning of scientific study, and their responses have been recorded and coded. In 1995 and 1997, each respondent was asked the same openended question about scientific study and given a set of questions concerning an experimental evaluation of a drug. ⁷ They were also asked a set of questions concerning the meaning of probability, using an example of an inherited illness. ⁸ Each respondent was classified, using a combination of these responses, as having or not having at least a minimal level of understanding of the nature of scientific inquiry. ⁹ In 1997, approximately 27 percent of American adults met the standard of having a minimal understanding of the nature of

scientific inquiry, continuing a gradual increase over the last decade. (See figure 7-9 and appendix table 7-11.)

International Comparisons

It is possible to obtain a sense of international commonalties and differences by comparing the mean scores on the Index of Scientific Construct Understanding for 14 of the leading industrial nations. Using the 100-point index described above, the United States, Denmark, the Netherlands, and Great Britain all produced mean scores of between 53 and 55. (See figure 7-10 and appendix table 7-12.) Although the years in which the data were collected from the other countries range from 1989 to 1992, the provision of the three time periods for the United States illustrates the stability of the U.S. estimate; there is no basis for assuming a more rapid change in other major industrial nations.

The results of the Third International Mathematics and Science Study (TIMSS) are relevant to this discussion since they showed that students in the United States ranked in the middle range of industrial countries. (See chapter 1.) There are a number of plausible reasons why American adults may



⁷The question on the meaning of scientific study was:

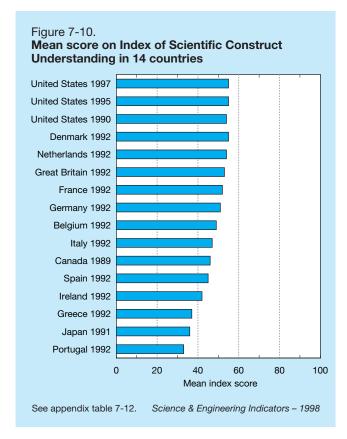
[&]quot;When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?"

If response is "clear understanding" or "general sense": "In your own words, could you tell me what it means to study something scientifically?" In addition, each respondent was asked the following question:

[&]quot;Now, please think of this situation. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to nother 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?"

⁸The text of the probability question was: "Now think about this situation. A doctor tells a couple that their 'genetic makeup' means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple's children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?"

⁹The level of understanding of the nature of scientific inquiry is estimated by looking at responses to a series of open-ended and multiple-part questions. To qualify as understanding the nature of scientific inquiry, a respondent had to (1) either provide a theory-oriented response to an open-ended question about the meaning of scientific study or provide a correct response to an open-ended question about an experiment and (2) be able to provide a correct response to a series of four separate queries about the meaning of the probability of one-in-four, using an example of an inherited illness.



score ahead of, or equal to, adults in other industrial nations. First, a higher percentage of U.S. youth have enrolled in postsecondary schooling for most of the last five decades. A second possible reason is that there has been and continues to be a more pervasive use of general education requirements in the United States, which include one or more years of college-level science instruction for all college students, regardless of degree or career objective. In Europe and Japan, fewer youth enroll in college or university, and postsecondary students who do not plan a career in science or related fields are not required to take college-level science or mathematics courses. It is also possible that college-level science instruction in the United States is enhanced by informal science learning resources. These include zoos, aquariums, museums, science television programs, science magazines, public libraries, and the World Wide Web. Other reasons are based in the methodologies of these studies. The ability of TIMSS performance to predict a student's adult knowledge has not been established. Different testing instruments and procedures can lead to substantial differences in results. The factors associated with these differences merit further study.

Attitudes Toward Science and Technology Policy Issues

One of the areas of inquiry that social psychology and learning research has focused on is the development of public attitudes toward a variety of subjects. How humans learn, think, and develop cognitive structures is an evolving and complex area of research. Some of the social psychology concepts are helpful in the analysis of public attitudes toward science and technology. Some social psychology literature indicates that most individuals, when faced with a daily barrage of complex information, often construct schemas to filter and manage information (Schank 1977; Minsky 1986; Lau and Sears 1986; Milburn 1991; and Pick, van den Broek, and Knill 1992).

A schema is a psychological structure that humans use to integrate information and experiences into coherent clusters. Individuals have schemas for simple tasks (such as driving an automobile in traffic) as well as for more complex and abstract tasks (such as understanding the impact of science on society). Schemas are usually cumulative in character and help people categorize new information while also providing an initial filtering response to the information. For example, when a driver sees a lighted arrow pointing to one side of a highway, it is likely that the driver will assume the need to turn in that direction, and may also reason that it will be necessary to slow the vehicle first. The original observation of the lighted arrow activates various prior experiences and knowledge, bringing into short-term memory a set of alternative explanations and associated behaviors.

Similarly, when an individual hears or reads a news report that a new drug tested on a large number of animals was found to reduce the development of cancer, that information may be recognized as a "scientific study" and one or more schema relevant to this subject may be activated. Although the report involves tests of a drug on animals, the individual may recognize that the results could lead to studies with more advanced animals or with humans, ultimately resulting in a drug that might be useful to humans. An individual with a strong positive schema toward science may interpret this report optimistically, expecting new medications in the foreseeable future, and reinforcing a belief that science produces things that make life healthier, easier, and more comfortable. Conversely, an individual with a strong negative schema toward science may recall other test reports that have promised results, but failed to produce them.

It is important to explore the structure of public attitudes toward science and technology in the United States and to compare it with structures found in other industrial nations. To do that, a series of analyses was conducted, and two independent dimensions were found that support the view that most individuals hold two primary schemas toward science and technology. The first dimension appears to represent belief in the promise of science and technology. A careful reading of the four items included on this dimension indicates that they all reflect either the judgment that science and technology have already improved the quality of life, with the implicit assumption that this will continue, or make a positive assessment of the likelihood of future benefits. The second dimension appears to represent personal reservations about science and technology. The four items included on this dimension express concerns about the speed of change in modern life and a sense that science may, at times, pose conflicts with traditional values or belief systems.

It is reasonable to expect many combinations of these two schemas. Some individuals may have a strong belief in the promise of science and technology and a low level of concern, leading them to react positively to a wide spectrum of science news. Alternatively, some individuals may have lower expectations about the promise of science and technology and a higher level of concern, leading them to be doubtful or negative about scientific news. It is also possible for an individual to hold both hope in the promise of science and technology and real reservations about their potential harms or dangers. Given the low salience of science and technology to many adults, it is likely that some people will have both low expectations about the promise of science and technology and little awareness or concern about potential drawbacks.

To provide a common metric for comparison, a 0-100 index was constructed for the Index of Scientific Promise and the Index of Scientific Reservations. The mean score of U.S. adults on the Index of Scientific Promise was 70 in 1997, and the mean score on the Index of Scientific Reservations was 37. (See appendix tables 7-13 and 7-14.) Although the ratio between the two indices may show the relative strength of positive and negative attitudes toward science and technology, both schema operate simultaneously in most individuals. This pattern means that most Americans hold strong beliefs in the promise of science and technology to improve the quality of life and have relatively low levels of reservation about possible harms. Comparable indicators from 1992 and 1995 suggest that this pattern of American attitudes has remained stable in recent years.

A comparison of the United States and 13 other industrial nations shows that the citizens of most industrial countries hold strong positive beliefs about the promise of science and technology to improve the quality of life. (See appendix table 7-16.) The citizens of the other 13 industrial nations had a mean score around 70 on the Index of Scientific Promise, suggesting a pervasive belief in the potential benefits of science and technology to improve the quality of life.

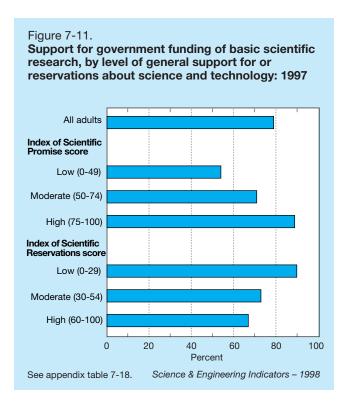
There are, however, major differences among industrial nations in the level of reservation, or concern, about potential negative effects of science and technology on traditional values and on the pace of life. Among industrial nations, American adults report the lowest levels of reservation about science and technology, with a mean score of 37. Canadians and most Europeans recorded mean reservation scores between 50 and 60, but the citizens of Greece and Portugal displayed mean scores above 66. This pattern suggests that these citizens simultaneously believe in the promise of science and technology to improve the quality of life, and hold a slightly lower—but substantial—level of concern about potential negative impacts of science and technology.

Japan is an interesting exception to this pattern. The mean score for Japanese adults on the promise index was 55, but the mean score on the reservation index was 56. The level of reservation is comparable to Canada and most European countries, but the level of belief in the promise of science and technology to improve the quality of life is essentially equal to the level of concern. While this pattern is surprising in the context of Japanese success in science and technology in recent decades, it may be a reflection of a traditional society experiencing a faster pace of social and economic change than earlier generations.

The Linkage Between Schema and Specific Policy Preferences

To learn how these general schema function with regard to specific policy preferences, it is useful to view the responses of Americans to the statement, "Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the Federal Government." Nearly 80 percent of Americans agreed with that statement in 1997, and only 18 percent explicitly disagreed with it. (See figure 7-11 and appendix table 7-17.) The same question has been asked of Americans in each of the *Science & Engineering Indicators* studies since 1985, and the results suggest that this level of support has been stable for at least a decade. Approximately 90 percent of American adults with a baccalaureate degree have voiced approval for this statement since 1985.

A careful examination of the data from 1997 suggests that these two schema play an important intermediary role in the development of specific policy preferences, such as the preference for government funding for basic scientific



¹⁰See appendix table 7-14 for the frequency distribution of the eight items included in the two schema.

¹¹Some of the items included in the Index of Scientific Reservations and the Index of Scientific Promise were included in the Attitude Toward Organized Science Scale that was reported in previous *Science & Engineering Indicators*. (See appendix table 7-15.)

research. About 54 percent of American adults who scored less than 50 on the Index of Scientific Promise agree that the Federal Government should fund basic scientific research. By contrast, 89 percent of adults with a score of 75 or more on the index supported that funding. (See figure 7-11 and appendix table 7-18.) Similarly, the level of support ranges from 67 percent among adults with a high level of reservation about the impact of science and technology to 90 percent among adults with a low level of reservation. By itself, this pattern would suggest that both of these schema operate simultaneously and in opposite directions, but other factors such as level of education and the number of science courses taken—influence the general schema themselves; thus, the relationship is more complex. The influence of education, for example, can be seen in the percentage of support by schema score among those with different levels of education. (See appendix table 7-18.) These results confirm that both the promise schema and the reservation schema continue to operate within every level of formal education.

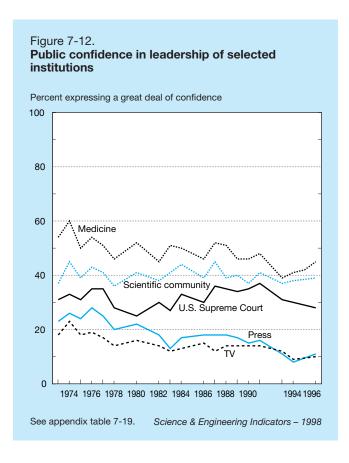
The results show that schema—general and long-term attitudinal filters—play an important role in the formulation and maintenance of more specific policy attitudes and preferences. It is useful to examine some additional indicators of public attitudes toward organized science in the United States.

One of the oldest indicators of the public attitude toward science and technology is the General Social Survey query (Davis and Smith annual series), which asks Americans whether they have a "great deal of confidence, only some confidence, or hardly any confidence at all" in the people running selected institutions. About 40 percent of Americans express a great deal of confidence in the leadership of the scientific community, trailing only the leadership of medicine. (See figure 7-12 and appendix table 7-19.) Comparatively, only 10 percent of adults expressed a great deal of confidence in the leadership of the press or television in 1996. This level of esteem for the leadership of the scientific community has continued during the two decades that these data have been collected.

Perceptions of Scientific Research

The longest available indicator of the relative benefits and harms of science is a question that Americans were first asked only weeks before the launch of Sputnik I in 1957. Asked to judge whether the world is better or worse off because of science, 88 percent of American adults said they thought the world was better off, and only 3 percent said that the world was worse off (Davis 1958). In the 1988 Science & Engineering Indicators study, this question was repeated and 88 percent still said that the world was better off due to science. In 1997, 40 years after Sputnik, 87 percent indicated that they felt that the world is better off because of science, and only 5 percent said that the world is worse off due to science. This pattern reflects a consistent post-war belief among Americans that science will improve the quality of life.

When asked in 1997 to weigh the benefits and harms of "scientific research," 75 percent of Americans indicated that the benefits had exceeded any harms, and only 12 percent



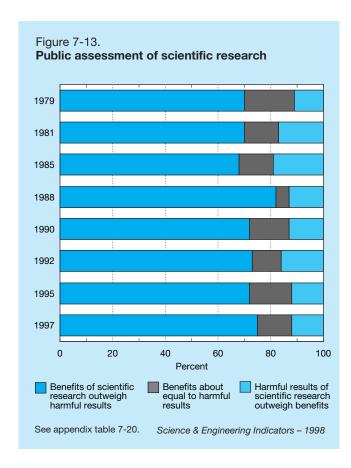
took an opposing view. (See figure 7-13 and appendix table 7-20.) In 1997, 90 percent of Americans with a college degree indicated that the benefits of scientific research outweigh any harms, compared to 58 percent who did not finish high school. Of the attentive public for science and technology policy (those most likely to become involved in science or technology policy disputes), 83 percent believed that the benefits of scientific research outweigh any harms.

Perceptions of Nuclear Power

Americans are not as positive about all scientific issues as they are about scientific research generally. For example, they have been evenly divided for more than a decade over the use of nuclear power to generate electricity. In 1997, 45 percent of Americans believed the benefits of nuclear power outweighed any harms, while 37 percent held the opposite view, and 18 percent thought that benefits and harms were equal. (See figure 7-14 and appendix table 7-21.)

Individuals with more years of formal schooling, males, and citizens attentive to science and technology policy were slightly more favorable in their assessment of the benefits and harms of nuclear power than other Americans, but the differences were modest. (See appendix table 7-21.) The relationship between education and the assessment of nuclear power was relatively weak.

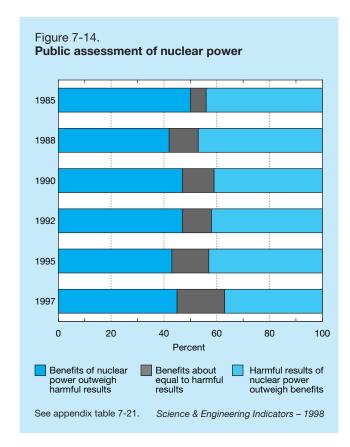
¹²These differences in attitudes by sex toward nuclear power are consistent with the findings of other studies conducted in the United States and Europe (Shapiro and Mahajan 1986, Norris 1988, and Poole and Zeigler 1985).



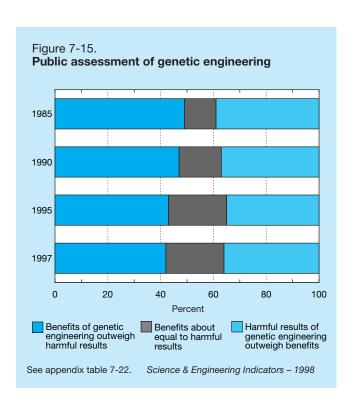
Perceptions of Genetic Engineering

During the last 15 years, media discussion of genetic modification has increased markedly. The subject has been raised on television and in films, criminal trials, and person-of-the year awards. Americans continue to be divided in their assessment of the benefits and harms of genetic engineering. In 1997, 42 percent of Americans thought that the benefits outweighed the harms, but 36 percent concluded that the actual or potential harms were greater than the benefits. (See figure 7-15 and appendix table 7-22.) In 1995 and 1997, more Americans were undecided or thought that the harms equaled the benefits than a decade ago.

Several interesting patterns emerge regarding education, attentiveness, and sex. (See appendix table 7-22.) With respect to education, individuals with less than a high school diploma gradually shifted from more positive attitudes toward genetic engineering to more negative assessments between 1985 and 1997. Increased media attention to this topic seems to have created more worries, which create negative assessments for this population. Among high school graduates, the positive assessment of genetic engineering has remained relatively stable, while negative assessments have declined slightly. This period has seen growth among high school graduates in uncertainty or in the belief that benefits equal harms. A similar pattern can be found for college graduates, with the majority believing that the benefits outweigh the harms, but an increasing proportion expressing either



uncertainty or the view that benefits and harms are about equal. These findings are similar to what Nelkin (1977) saw regarding nuclear power in Sweden. Nelkin found that as information about nuclear power increased, the percentage of individuals who felt undecided about its use also increased.



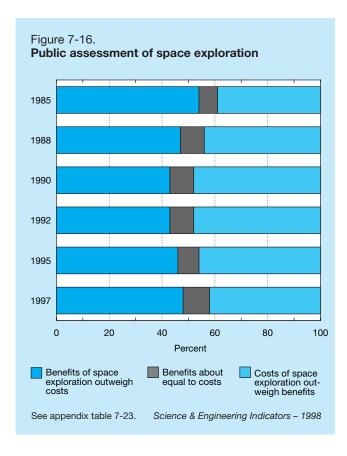
These data show that a majority of the attentive publics for science and technology policy and for biomedical research (medical discoveries) has held a positive assessment of the benefits and harms of genetic engineering since 1985. (See appendix table 7-22.) For both attentive publics, the proportion of citizens who see the benefits and harms as about equal, or who cannot determine the difference, has been growing since 1985.

There is a clear difference by sex on this issue. In 1997, nearly 50 percent of men expressed a positive view of genetic engineering, compared to 37 percent of women. (See appendix table 7-22.) Approximately half of American men favored genetic engineering throughout the last decade. American women were nearly equally divided in 1997, with 37 percent indicating that the benefits outweigh the harms and 40 percent saying that the harms outweigh the benefits.¹³

Perceptions of Space Exploration

The balance between benefits and costs, rather than benefits and harms, has been important in assessment of the space program. While a majority supported the program in 1985, a small plurality of the public thought that the costs exceeded the benefits of space exploration in the early 1990s; public perceptions shifted toward the view that the benefits of space exploration exceeded its costs in 1997. (See figure 7-16 and appendix table 7-23.) This pattern of change offers an interesting insight into the role of attentive publics for low-salience issues.

In 1985, immediately prior to the Challenger accident, 54 percent of Americans thought that the benefits of the space program outweighed its costs. However, 66 percent of the attentive public for science and technology policy, and 74 percent of the attentive public for space exploration, believed that the benefits outweighed the costs and tended to hold strong feelings on this matter. The explosion of the Challenger produced an immediate increase in support for the space program in all segments of the American public (Miller 1987), but the grounding of the shuttle program for more than two years eroded a great deal of that support. Through the late 1980s and early 1990s, support was declining in both the general public and among those attentive to science policy. By 1992, however, fully 82 percent of the attentive public for space exploration believed that the benefits of the space program were greater than its costs. Although the interviews for the present Indicators study were largely completed prior to the Mars landing, a series of successful shuttle flights and a steady flow of images from the Hubble Space Telescope produced a small surge in public support.



By the summer of 1997, 48 percent of American adults felt that the benefits of the space program exceeded its costs, while 42 percent of adults continued to think that the costs were greater than the benefits. (See appendix table 7-23.) At the same time, 66 percent of the attentive public for science and technology policy, and 76 percent of the attentive public for space exploration, indicated that the benefits exceeded the costs.

Sources of Scientific and Technical Information

In recent decades, there has been a marked increase in the number and variety of sources providing information about science and technology. Hajor weekly news magazines generally have a section on science or medicine and a section on computers and networks. The number of popular science books continues to grow, and many reviewers conclude that the quality of them is increasing. There has been substantial growth in cable television coverage of science and technology, and the number and quality of science-related sites on the World Wide Web grows daily. In this context, it is interesting to find out which Americans are using which kinds of science and technology information sources, and to what effect.

¹³Hoban and Kendall (1993), in a study conducted in the United States, also found that men hold more positive views of biotechnology. A 1993 European study of attitudes toward biotechnology also found that men hold more positive attitudes toward biotechnology and genetic engineering (see Marlier 1993).

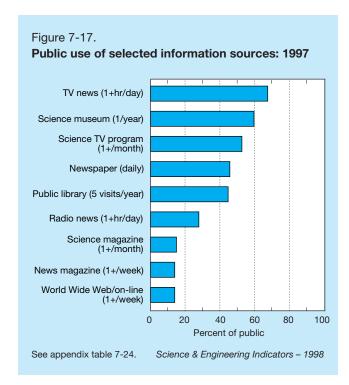
¹⁴See Lewenstein (1994) for a survey of public communications about science and technology in the United States.

General Patterns of Information Acquisition

Building on trend data from previous Science & Engineering Indicators studies, it appears that Americans utilize numerous sources and institutions for scientific and technical information, but television and newspapers remain primary sources. In 1997, 68 percent of American adults reported that they watched a television news show for at least one hour on a typical day, and 46 percent indicated that they read a daily newspaper. (See figure 7-17 and appendix table 7-24.) Over onequarter of Americans listen to one or more hours of radio news on a typical day, and 14 percent claim to read a weekly news magazine on a regular basis. Fifteen percent reported that they read a science magazine on a regular basis. These same results show that 70 percent of Americans use a public library at least once each year and that 45 percent claim to use a pubic library five or more times each year, although it is not possible to determine from the data whether science materials were utilized. Approximately 27 percent¹⁵ of American adults now have access to the World Wide Web, and approximately 28 percent¹⁶ report having an e-mail address at home or at work.

In broad terms, these indicators are threshold measures, reflecting the percentage of Americans who used various information sources more than some minimal threshold in a typical month or during the previous year. Using the same database, it is also possible to estimate the volume of use of these information sources and to place them all on the same metric—the number of uses or hours of use per year. By comparing differ-

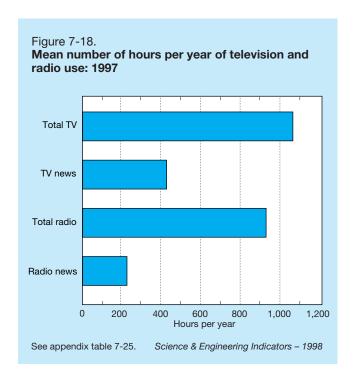
¹⁶This estimate combines those individuals who have an e-mail address either at home or at work, and is not reported as a separate category in the appendix tables.



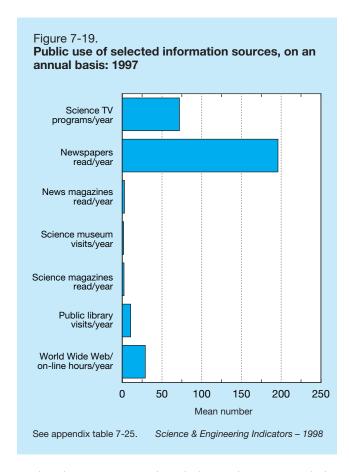
ent information sources on the same metric, it is possible to obtain a more useful picture of the patterns of potential scientific and technical information acquisition.

Regarding broadcast media, the 1997 results indicate that Americans watch an average of 1,075 hours of television each year and that 432 of those hours are devoted to television news. (See figure 7-18 and appendix table 7-25.) In this context, Americans report that they watch an average of 72 hours of science television per year. Since respondents in 1997 were asked the name of each show that they claimed to watch regularly or periodically, this is a credible estimate of viewership. The frequency of viewing science television shows is unrelated to the number of years of formal schooling or to the number of science and mathematics courses taken in high school and college. It is apparent, however, that individuals who subscribe to a cable television service or have a satellite dish watch significantly more science television shows than individuals without cable or satellite services. In 1997, cable subscribers reported watching an average of 84 hours of science television shows, compared to 35 hours for individuals without cable or satellite service. Men were significantly more likely to watch science television shows than were women.

Among print media, newspaper reading is dominant. In 1997, Americans reported reading an average of 196 newspapers during the previous 12 months. (See figure 7-19 and appendix table 7-25.) Comparatively, Americans read an average of three news magazines and two science magazines during the same 12-month period. Americans in 1997 used a public library 11 times during the year and borrowed 12 books and 2 videotapes from the public library. Sixty-one percent of American adults reported that they bought one or more books during the previous year; and 31 percent indicated that at least one of the purchased books involved science, mathematics, or technology (including computer use).



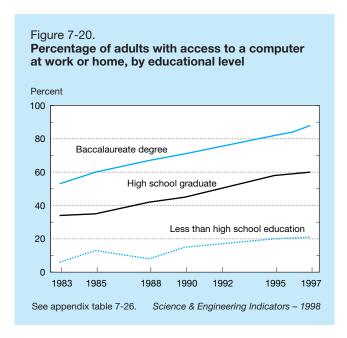
¹⁵This estimate includes individuals with access to the World Wide Web through their home computer, their work computer, and through Web television (not reported in the appendix tables).



During the same 12-month period, Americans reported visiting a science museum, natural history museum, zoo, or aquarium an average of two times.

The reading of newspapers, news magazines, and science magazines is positively related to the number of years of formal schooling and the number of high school and college science and mathematics courses. (See appendix tables 7-24 and 7-25.) The individual with a graduate degree read approximately 238 newspapers, 6 news magazines, and 4 science magazines in a 12-month period. It appears that high school and college science and mathematics courses stimulate a lasting interest in science and technology, as reflected in the patterns of science magazine reading and science museum attendance. Men were significantly more likely to read a science magazine than were women.

Citizens attentive to science and technology policy issues displayed a high level of information consumption, utilizing both broadcast and print sources. Science policy attentives reported slightly more hours of television news viewing than other citizens, and they read significantly more newspapers than other Americans. (See appendix table 7-25.) Science and technology policy attentives read significantly more news magazines and science magazines than other citizens, and were more frequent visitors to public libraries than non-attentives. The members of the attentive public for science and technology policy were more likely than other Americans to visit a science and technology museum or other informal science learning resource.



Use of New Information Technologies

The 1990s was a period of emergence of electronic media. Over the last decade, individual access to computers at work or at home has increased substantially and steadily. (See "The Use of Computer Technology in the United States.") By 1997, 57 percent of Americans reported using computers at work, at home, or both. (See figure 7-20 and appendix table 7-26.) Fully 88 percent of college graduates in the United States indicated that they used a computer at work or at home, compared to 60 percent of high school graduates and 21 percent of those who did not complete high school. In 1997, two-thirds of the attentive public for science and technology policy reported that they had regular access to a computer at work or at home.

The 1997 results show that Americans do a substantial amount of work on their computers. The average respondent reported spending 369 hours a year using a work computer and 130 hours using a home computer.¹⁷

A third of Americans have a home computer that includes a modem, and 18 percent report using an on-line or Internet service. (See appendix table 7-27.) Nearly two-thirds of Americans with a graduate degree or professional education have a home computer with a modem, and 41 percent reported that they use an on-line service. Over half of the attentive public for science and technology policy reported that they own a home computer and use it an average of 225 hours per year. Nearly half of this attentive public have a home computer with a modem, and are thus better positioned to make extensive use of the Internet and its information resources.

Twenty-nine percent of Americans indicated that they have a home computer that includes a CD-ROM reader, a technology that opens important new information resources ranging from larger reference works to collections of visual images with sound. The number of government agencies and private organizations

¹⁷The hours of computer use by individuals who reported that their place of business was in their home were counted as work hours.

The Use of Computer Technology in the United States

Three new indicators collected for the first time in 1997 illustrate the broad and growing use of computers and computer-based technologies by American adults. First, 43 percent of Americans lived in a household in 1997 with one or more working computers, and 11 percent of Americans reported that they have more than one working computer in their home. (See figure 7-21.) In contrast, in 1983, only 8 percent of American adults had access to a home computer.

The distribution of home computers and of multiple home computers is strongly related to level of educational attainment. Three-quarters of adults with a graduate or professional degree own a home computer, with 29 percent having two or more working computers in their home. Similarly, 24 percent of individuals with extensive high school and college coursework in science and mathematics reported having two or more working computers in their home, as did 16 percent of the attentive public for science and technology.

Second, approximately 28 percent of Americans have an e-mail address, and 5 percent of U.S. adults—about

9 million individuals—have two or more e-mail addresses. (See figure 7-22.) The multiple e-mail addresses appear to reflect one e-mail address associated with work and a second e-mail address for home or family use.

The distribution of e-mail addresses is strongly related to the level of educational attainment. Slightly more than 60 percent of adults with a graduate or professional degree have at least one e-mail address, and 19 percent have two or more e-mail addresses. A similar pattern is found among baccalaureate-holders, with 55 percent having an e-mail address and 16 percent having two or more e-mail addresses. Furthermore, 60 percent of individuals with extensive high school and college coursework in science and mathematics reported having an e-mail address, as did 42 percent of the attentive public for science and technology.

Third, approximately 16 percent of Americans reported having access to the World Wide Web from their home computer in 1997. To understand how individuals use the Web, all respondents in the *Indicators* study were

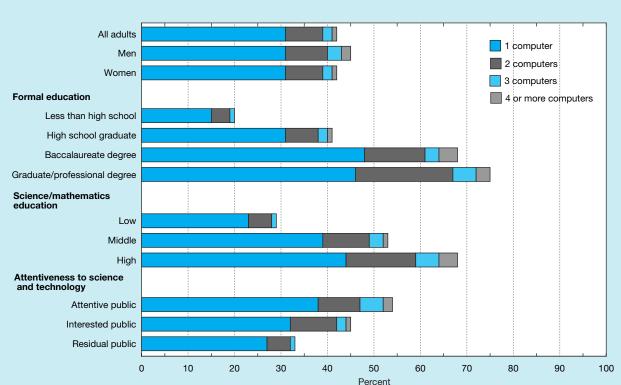


Figure 7-21.

Percentage of U.S. adults with one or more home computers: 1997

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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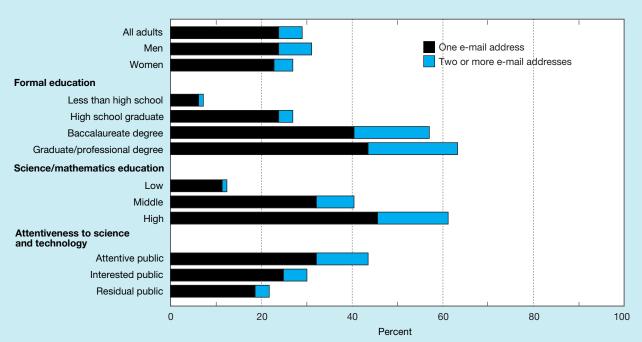


Figure 7-22. Percentage of U.S. adults with one or more e-mail addresses: 1997

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

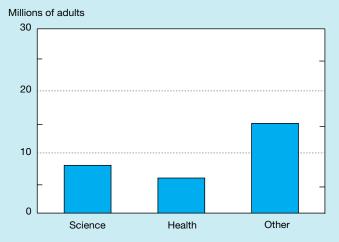
asked if they had tried to obtain any specific information from the Web, or whether they primarily browsed the various sites on the Web. Twelve percent of adults sampled—representing approximately 22 million people—indicated that they had previously tried to find some specific item of information on the Web. This pattern of response indicates that people are using the Web as they might use reference materials in a library.

Each respondent who reported some prior effort to find specific information on the Web was asked to describe in general terms the kind of information that he or she was seeking. An analysis of these responses indicated that approximately 6.5 million Americans had attempted to find some information on the Web about a specific health condition or problem, and approximately 8.8 million had tried to find some scientific information on the Web—including information on the space program, environmental information, and computer information. More than 15 million adults reported that they attempted to find other kinds of specific information on the Web. (See figure 7-23.)

While these results indicate that the vast majority of Americans do not presently use the Web as an information source, the relatively high level of use reported among the first segment of the American population to obtain Web access suggests that it is likely to become a major source of reference-type information in the decades ahead, as the total level of Web access continues to expand.

Figure 7-23.

Estimated number of U.S. adults seeking specific information on the World Wide Web, by subject area: 1997



SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science* and *Technology*, 1979-1997, *Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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that are distributing information in this medium is growing rapidly. As with other electronic media, better educated Americans are the most frequent users of this new technology.

Americans use a wide variety of sources to obtain new information, including information about science and technology. Americans with fewer years of formal education tend to rely on broadcast media, primarily television. College-educated Americans are frequent viewers of both television news and television science shows, but appear to rely more heavily on print media and, increasingly, on electronic information sources.

Summary

Science and technology are subjects of substantial interest to Americans. Using a 100-point Index of Issue Interest, the mean level of interest in new scientific discoveries has increased from 61 in 1979 to 70 in 1997, indicating that science and technology are becoming an increasingly integral part of the American culture. Individuals with more years of formal education and more courses in science and mathematics are more likely to show a high level of interest in science and technology. Comparatively, 70 percent of Americans expressed a high level of interest in medical discoveries and 52 percent indicated that they were very interested in environmental issues, but only 32 percent reported a high level of interest in space exploration.

Despite the high levels of interest, only 19 percent of Americans think that they are very well-informed about science and 16 percent about the use of new inventions and technologies. Americans with more years of formal education and more courses in science and mathematics are significantly more likely to view themselves as being very well-informed than others, and men are significantly more likely to indicate that they are very well-informed about science and technology, holding constant the level of formal education and the level of science and mathematics education.

Using a more objective standard reveals that many Americans have a limited vocabulary of scientific and technical concepts. On a 0-100 scale, the mean score on the Index of Scientific Construct Understanding was 55. This score has remained relatively constant since 1988. Individuals with more years of formal schooling and more courses in science and mathematics obtained significantly higher scores, demonstrating the pervasive effect of science and mathematics education throughout the adult years. Compared to 13 other industrial nations, the mean score for American adults on the Index of Scientific Construct Understanding was tied for first with Denmark, closely followed by the Netherlands and Great Britain.

Only 27 percent of Americans understand the nature of scientific inquiry well enough to be able to make informed judgments about the scientific basis of results reported in the media. Public understanding of the nature of scientific inquiry was measured through questions about the meaning of scientific study and the reasons for the use of control

groups in experiments. Individuals who have completed more years of formal schooling and more courses in science and mathematics were significantly more likely to understand the nature of scientific inquiry than other citizens.

Approximately 27 million Americans—14 percent—are attentive to science and technology policy issues, a level that has increased since 1995. In complex modern societies, it is not possible for citizens to become and remain informed about the full range of public policy areas, and some degree of issue specialization is inherent in these societies. About half of Americans indicate that they are interested in and informed about at least one public policy area, and, among those citizens who follow any public policy issues, it appears that most of them follow two or three issues at any given time.

Americans get most of their information about public policy issues from television news and newspapers. When placed on a uniform scale of the number of uses or hours per year, the public consumption of television news and newspapers dwarfs all other information sources. In 1997, Americans watched an average of 432 hours of television news and read 196 newspapers. During that period, Americans watched 72 hours of television science programs. Individuals with cable or satellite TV service watch more science television programs than those without this service.

Fifty-seven percent of Americans use a computer at home or at work, and computer use has increased steadily during the last decade. In 1997, Americans used a computer at work for 369 hours and used their home computer for an additional 130 hours. A significantly higher proportion of college graduates use a computer than individuals with fewer years of schooling.

In 1997, nearly one-third of Americans had a home computer that included a modem, and 18 percent of adults reported that they had used an on-line computer service during the preceding year. This is a significant increase in home access to on-line resources in the last two years alone. Moreover, 29 percent of adults in the United States reported having a home computer with a CD-ROM reader, opening additional information acquisition opportunities. Nearly two-thirds of Americans with a graduate or professional degree have a home computer with a modem, and 41 percent reported that they use an on-line service.

Americans continue to hold the scientific community in high regard. According to the most recent General Social Survey in 1996, approximately 40 percent of Americans expressed a great deal of confidence in the leadership of the scientific community and in the leadership of the medical community. This confidence has been stable for nearly two decades and is far higher than the levels reported for the leadership of most other major societal institutions.

Americans have high levels of belief in the promise of science and technology, with an average score of 70 on a 0-100 scale. They hold low levels of reservation about science and technology, with an average score of 37. These levels of reservation are the lowest reported among citizens of industrial nations. Compared to the citizens of 13 other industrial nations, Americans registered a strong belief in the promise

of science and the lowest level of reservation about science and technology.

Seventy-five percent of Americans believe that the benefits of scientific research outweigh any present or potential harms. This level of positive assessment of scientific research has been stable for nearly two decades and reflects the high esteem in which the public holds the scientific community. College graduates and citizens attentive to science and technology policy hold even more positive views of science.

Despite their positive views of scientific research, Americans are deeply divided over the development and impact of several important technologies. They are relatively evenly divided on the benefits and harms of using nuclear power to generate electricity, and this division has persisted for more than a decade. A similar division occurs over the benefits and potential harms of genetic engineering, but there is a clearer difference by level of education, with college graduates holding much more positive views of genetic modification research. Regarding the space program, a small plurality of the general public believes that the benefits of the space program exceed its costs. College graduates and the attentive public for space exploration have continued to hold very positive attitudes toward the space program throughout the last decade.

Overall, the American public appears to continue to expect science and technology to improve the quality of life, and the scientific community is accorded a higher level of trust and confidence than other major societal institutions. Nonetheless, the concerns regarding several specific technologies indicate that the public has not given the scientific community a blank check. The public wants to know what is happening, and the scientific community needs to communicate its work ever more clearly and effectively.

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Chapter 8 Economic and Social Significance of Information Technologies

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Highlights

IT AND THE ECONOMY

- ♦ The use of information technologies (IT) is pervasive in the United States. The real net computing capital stock in the private sector was \$155.8 billion in 1995. And, in many industries, the number of employees who use a computer at work is more than 50 percent; in the banking industry, it is 85 percent.
- ◆ IT is believed to have contributed to the country's structural shift to a service economy. In the United States, growth in services as a proportion of gross domestic product has been led exclusively by IT and knowledge-intensive industries such as finance, insurance, real estate, and professional services.
- ◆ The U.S. Bureau of Labor Statistics projects employment in IT-producing industries to nearly double from 1986 to 2006. This expansion is due almost entirely to growth in computer and data processing services (including software manufacturing); employment declines are projected for the IT hardware industries. Since precise projections are always difficult, this should be taken as a general direction, not an exact level of employment.
- ♦ Several comprehensive studies, using a variety of data and methods, indicate that there is an overall skill upgrading taking place in the labor force, a trend attributed to the greater use of IT in many occupations.
- ◆ The incidence of IT-related injury and employee surveillance in the workplace are on the rise, but impacts on individuals are uncertain.
- ♦ Recent research suggests—unlike past evidence of a "productivity paradox"—that there may be measurable productivity gains from IT. Nonetheless, it is difficult to predict the precise organizational and firm-level conditions that foster the effective use of IT.

IT AND EDUCATION

- ♦ By 1992, 80 percent of all K-12 schools had 15 or more microcomputers for instruction. In 1996, 85 percent of all schools had access to multimedia computers, 65 percent had Internet access, and 19 percent had a satellite dish. Internet linkages are not necessarily widely accessible within schools—in 1996, only 14 percent of instructional classrooms had an Internet hook-up.
- ♦ In fifth grade, more than half (58 percent) of the instructional use of computers is for teaching academic subject matter. By 11th grade, less than half (43 percent) of computer-based instruction is for content; 51 percent is for computer skills training.

- ♦ Meta-analyses of educational studies conducted between the late 1960s and the late 1980s consistently reveal positive impacts of computer-based instruction at the K-12 level. Estimates of the order of magnitude vary, but one meta-analysis of 40 studies gave evidence of learning advantages that ranged from the equivalent of one-third to one-half of a school year for K-6 education.
- ♦ The cost effectiveness of computer-based instruction relative to other forms of instruction has not been demonstrated. As pressures to increase IT spending grow, it is likely that school districts will face greater opportunity costs between IT and other education-related expenses.
- ♦ There is significant educational inequity in access to computers and the Internet. Schools whose student body is represented primarily by minority or economically disadvantaged students have one-third to three times less access to these technologies than do schools attended primarily by white or nondisadvantaged students.
- ♦ Poor and minority students cannot compensate for less computer access at school in their homes. In 1993, blacks and Hispanics had half as much ownership of home computers as whites. The poorest and least educated groups had about one-tenth the access to home computers as the most affluent and educated groups. Research indicates that when the "informationally disadvantaged" are given access to computers and the Internet, they use these resources effectively for self-empowerment.

IT AND PRIVATE CITIZENS

- ♦ Concerns about information privacy are growing larger and stronger. In a 1996 Equifax/Harris privacy survey, two-thirds of the respondents said that protecting consumer information privacy was very important to them.
- ♦ The vast majority of Americans believe that companies should be prohibited from selling information about consumers—including their income, bill-paying history, and product purchases—and that stiff restrictions should be placed on access to medical records. Unfortunately, most Americans also believe that they have already lost control of personal information about themselves.

Introduction

Chapter Overview

The revolution in information technologies (IT) has been likened to the industrial revolution in terms of its potential scope and impact on society (Alberts and Papp 1997; Castells 1996; Freeman, Soete, and Efendioglu 1995; and Kranzberg 1989). With the exception of electrification, no other modern advances in technology have had the capacity to affect so fundamentally the way people work, live, learn, play, communicate, and govern themselves. Indeed, some social philosophers expect that IT might affect the nature of what it means to be human—changing values, emotions, and cognitive processes.

Science & Engineering Indicators – 1998 attempts to benchmark certain dimensions of the growing role of information and information technologies in American society. At present, there is little systematic data on either the diffusion of IT or its impacts on society. Metrics are confounded by both the fuzziness of IT as a concept and the interactive effects of so many social variables—including age, ethnicity, income, learning processes, individual attitudes, organizational structures, and management styles. In addition, the rate of technological change since the early 1980s has often outpaced our ability to define what it is we want to know and what data ought to be collected.

As a consequence, this chapter focuses on three core areas where the analytical questions have stabilized and where there is a large body of existing research:

- ♦ the role of IT in the national economy;
- ♦ the influence of IT on K-12 student learning; and
- the impact of IT on citizens, particularly with respect to equity and privacy.

Each of these areas illustrates the ways in which sciencebased technology can have profound social consequences (both positive and negative) and the difficulties in defining, measuring, and tracking a technology that is still emerging.

Three generalizations can be made about the state of our empirical understanding of IT's effects on society. First, quantitative indicators of IT diffusion are relatively abundant but not necessarily regularly updated. Second, indicators of the actual effects of IT on individuals, institutions, and markets are extremely difficult to establish. Currently, statistical studies in many areas of interest are both nonrepetitive and noncumulative; that is, studies do not necessarily use the same methodologies (thus generating different statistics) and do not build on one another (findings from one study are not verified and expanded on in others). This state of affairs has less to do with the quality and rigor of the research than with the complexity and dynamism of IT as a subject of study. Moreover, experts have not determined how to measure some elements of considerable interest, such as productivity in some service industries.

Third, the state of existing research makes it difficult to draw any definitive conclusions about the impacts of IT on society. For example, evidence exists of both increased and decreased productivity, as well as of both a lowering and an upgrading of skills in the labor force. Both positive and negative consequences may also be found. For example, computer-aided instruction may clearly enhance some forms of student learning, but extensive use of some computing environments may interfere with aspects of child development. Positive effects (such as enhanced business performance or student learning) are often highly contingent upon the presence of a number of other factors, such as appropriate organizational structures, managerial style, the adequacy of teacher training, and the attitudes of the individual using IT. All that may be said definitively about IT's social and economic impacts is "it depends": both on how we have measured and modeled the subject of study, and on the all-too-human conditions surrounding its use.

The evidence and indicators presented in this chapter do cohere as a somewhat sketchy image of the social and economic impacts of IT as of the mid-1990s. The predominant feature reflects the scope and presence of IT in the economy, schools, and the home. In many industries, the level of computer use (as measured by the number of employees with computers on their desktop) exceeds 50 percent. More than 70 percent of large firms in key manufacturing sectors (such as machinery, electronics, and transportation) use computer-aided design and/or numerically controlled machine tools. In addition, many services (such as automated banking, credit card sale authorization, express delivery, and electronic commerce) could not exist in the absence of an IT infrastructure.

Elementary and secondary schools have similarly high rates of IT adoption. By the early 1990s, 80 percent of all K-12 schools had 15 or more instructional computers, and the national median number of students per computer was 14—essentially one computer per classroom. Less pervasive is access to the Internet in schools; in 1996, only 14 percent of the instructional classrooms nationwide were linked to the Internet. At the household level, roughly one-quarter of all homes had a personal computer (PC) in the early 1990s; these households were disproportionately wealthy and white. As discussed in several sections of this chapter, IT is not necessarily ubiquitous, and schools and homes reflect a real inequality in access to computers and other information technologies.

The effects of IT are most clearly visible at the "micro" level—that is, the level of the individual firm, classroom, household, etc. For example, the strongest indicators of economic enhancements from IT are seen with firm-level data sets and for impacts that reflect improvements in firm-level activities (such as transaction processing time, product quality, cycle times, and customer service and convenience). The measurable learning effects of computer-based instruction (CBI) are most pronounced for the elementary grades and for rote learning; computer-enhanced higher order thinking skills are harder to demonstrate, perhaps because of a lack of appropriate software, but also because of the greater emphasis on building computer skills in secondary school rather than on content learning.

Chapter Organization

This chapter begins with a discussion of the nature of information technologies and the issues involved with measuring the effects of IT on society. Subsequent sections address (1) the role of IT in the economy, (2) the effects of IT on K-12 education, and (3) IT and the citizen. The final section addresses the need for better IT metrics.

Information Technologies

IT reflects the fusion of two key technological changes: the development of digital computing and the ability to transmit digital signals through telecommunications networks. The foundation of all information technologies and products is the ability to represent text, data, sound, and visual information digitally. By integrating computing and telecommunications equipment, IT offers the ability to access stored (or real-time) information and perform an extraordinary variety of information-related tasks.

IT does not represent a single technology as much as it does systems of interactive technologies used for information processing. There are literally hundreds of commercial products—ranging from telephones to supercomputers—that can interact in an information processing system. The distinctly different functions of many of these products contribute to a sense of fuzziness about IT's technological boundaries. Keen (1995) suggests, however, that IT can essentially be grouped into four basic technological elements of information processing:

- ♦ tools to access information,
- telecommunications linkages (including networks),
- ♦ information processing hardware and software, and
- storage media.

Figure 8-1 illustrates the more common technologies that are used for each of these elements and reinforces the understanding of IT as an interactive system of multipurpose technologies rather than a single class of products.

The rapid social and economic diffusion of IT since 1980 has been stimulated by threshold technical changes in computing power, applications, telecommunications, and networks as well as concurrent reductions in the cost of technology. Text table 8-1 illustrates advances in computing power (measured as million instructions per second) that have occurred since the introduction of the first microprocessor, while text table 8-2 presents trends in the relative cost of this power for popular commercial microprocessors. Notably, the computer price deflator calculated by the U.S. Department of Commerce has declined more than fortyfold since 1977 (Warnke 1996).

The other key development in IT is the growing connectivity of computers and information—and, by logical extension, people. Computerized data exchange is the basis for automated teller machine (ATM) transactions, credit card authorizations, airline reservation systems, electronic commerce, and overnight delivery services. A more advanced system, electronic data interchange, is becoming a standard form of communication between suppliers and customers to streamline ordering, purchasing, distribution, and billing operations. The extent of this growing networking is evident in the diffusion indicators—one study estimates that the number of installed local area networks was just over 1 million in 1981, about 12 million in 1990, and close to 40 million in 1995 (Morrison and Schmid 1994). Use of the World Wide Web, a subsystem on the Internet (see "History of the Internet"), exploded with the introduction of the Mosaic search engine

Figure 8-1.

Technological components of an information processing system

Devices to access information

- Computers
- Telephones
- Scanners
- Smart cards
- TVs
- Automated teller machines (ATMs)

Telecommunications links

- Radio wave
- Telephone line
- Coaxial cable
- Fiber optic
- Satellite
- Cellular

Information processing

- Computer hardware -mainframes -minicomputers
 - -minicomputers
 -microcomputers
- Software
- -decision support
- -data visualization
- -hypermedia
- -business and home applications
- -expert systems

Storage media

- Hard drive
- Zip™ drive
- Floppy disk
- CD-ROM
- CD read/write
- Mag tape

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¹Local area networks are devices (computers, telephones, security systems, automated cash registers, etc.) connected into an information network, typically in a single building or very small geographic area.

Text table 8-1.

Trends in computing power

	Micro- processor	Transistors (thousands)	Million instructions per second	Word size (in bits)
1971	4,004	2.3	0.06	4
1974	8,080	6	0.64	8
1978	8,086	29	0.75	16
1982	80,286	134	2	16
1985	80,386	275	6	32
1989	80,486	1,200	20	32
1993	Pentium	3,100	100	32
1995	Pentium Pro	5,500	250	64

SOURCE: F. Moris, "Semiconductors: The Building Blocks of the Information Revolution," *Monthly Labor Review* (August 1996): 6-18.

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Text table 8-2.

Trends in computing price relative to speed

	Device	Million instructions per second	Price per million instructions per second (\$)
1975	IBM Mainframe	10	1,000,000
1976	Cray 1	160	125,000
1979	DEC VAX	1	200,000
1981	IBM PC	0.25	12,000
1984	Sun 2	1	10,000
1994	Intel Pentium Mi	icro 66	3,000

SOURCE: J. Warnke, "Computer Manufacturing: Change and Competition," *Monthly Labor Review* (August 1996): 18-30.

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in 1993. Market experts estimate that the Web had 69 million users in 1997 and about 80,000 servers; by 1996, about half of all U.S. companies had sites on the Web (IDC 1997).

The Information Society

The development, diffusion, and consequences of IT are part of a larger context: that of the "information age" or "information society." What exactly these concepts mean is uncertain, as they are not consistently used or explained in scholarly and popular discussions of the emerging information revolution. In an extensive review of writings about the information age, Webster (1997) concludes that it has five distinct analytical dimensions: technological, economic, occupational, spatial, and cultural. While not all analysts agree that human civilization is undergoing an information revolution, there is a pervasive sense that "information and com-

munications will become the dominant forces in defining and shaping human actions, interactions, activities, and institutions" (Alberts and Papp 1997, p. 1).

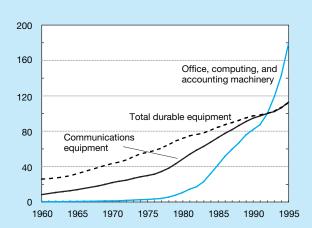
The present amount, variety, and accessibility of information within American society is unprecedented. Indicators of the economic and social diffusion of IT reveal that the technological capacity for information consumption has increased dramatically in the United States. The volume of IT is most substantial in the economic sector, where the real net computing capital stock was 200 times greater in 1995 than it was in 1975, and the real net communications equipment capital stock was five times greater than in 1975.4 (See figure 8-2.) In many industries, the number of workers who use a computer at their job now ranges from 50 to 85 percent (for more detail, see "Impacts of IT on the Economy"). In the manufacturing sector, U.S. Census data indicate that by the late 1980s, 83 percent of firms with 500 or more employees in the metals, machinery, electronics, transportation, and instrument industries used computer-aided design; 70 percent used numerically controlled machine tools (Berman, Bound, and Griliches 1994).

Extensive diffusion of IT is likewise found in the education sector. By 1985, more than three-quarters of all elementary and secondary schools had at least one microcomputer for student instruction. By 1992, all K-12 schools had at least one instructional microcomputer, and 80 percent had 15 or more computers. (See figure 8-5.) The median number of students per computer correspondingly declined from 42 in 1985, to 20 in 1989, to 14 in 1992—essentially the equivalent of one computer per

⁴In 1995, the total net capital stock of office, computing, and accounting machinery was \$155.8 billion; for communications equipment, it was \$388.5 billion (in current dollars). See U.S. BEA (1997), pp. 79-81.



(Chain-type index, 1992 = 100)



NOTES: Total durable equipment is nonresidential equipment. Chain indices are new constant value indices developed by the U.S. Bureau of Economic Analysis. IT is information technologies.

See appendix table 8-2. Science & Engineering Indicators – 1998

²For a thorough and up-to-date treatment of many of the issues surrounding the concept of the information society, see Alberts and Papp (1997).

³The cultural dimension includes education, governance, religion, values and ethics, and popular culture.

History of the Internet

For many Americans, nothing epitomizes IT as much as "the Net." The Internet is a meta-network for a variety of subnetworks and applications such as the World Wide Web, bulletin boards, Usenet newsgroups, e-mail, scientific data exchange, and more.

The foundation for the Internet was ARPANET, a network that started as four computer nodes in 1969. ARPANET was initiated by the U.S. Defense Advanced Research Projects Agency, and was based on a then-new telecommunications technology called "packet switching." ARPANET flourished as a medium for information and data exchange among universities and research laboratories. Moreover, it stimulated the development of TCP/IP, a communications protocol distributed with the UNIX operating system which has now become the standard for the Internet and other types of commercial telecommunications. By the late 1970s, ARPANET represented hundreds of computer nodes and had integrated several separate computer networks, including one based on satellite technology.

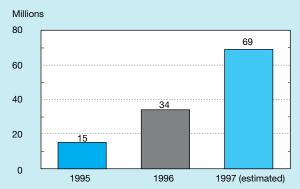
The "real" Internet resulted directly from the National Science Foundation's (NSF's) sponsorship of CSNET, and later, NSFNET (a high-speed network funded by NSF to link its supercomputing centers). NSFNET replaced ARPANET in 1990 and expanded to include a variety of regional networks that linked universities into the backbone network. Large numbers of smaller networks quickly linked into NSFNET—albeit without any planning, control, management, or security. By early 1994, commercial networks became widespread; almost one-half of all registered users of the network were commercial entities. Additionally, the amount and variety of information carried by NSFNET escalated.

Two related events dramatically reshaped the character of the Internet. First, scientists at the European Center for Particle Research (CERN) developed the World Wide Web and introduced it in experimental form in 1989. Second, in 1993, a team of programmers at NSF's National Center for Supercomputing Applications at the University of Illinois introduced Mosaic, a graphical (hypermedia) browser for exploring the Web. Because Mosaic was free and available to the public on the Internet, use of the Web (via Mosaic) soared. The number of Web users doubled annually from 1993 to 1996, and was estimated to be 69 million worldwide in 1997. (See figure 8-3.) Netscape, the leader in commercial Web browser software (accounting for 70 percent of the market), reported that in mid-1997, about 600,000 new users per week were accessing its software (NUA Ltd. 1997). And, compared to other countries, the United States has more Internet servers per capita than any other nation except Finland. (See figure 8-4.)

NSFNET was decommissioned in 1995, when there were enough commercial Internet service providers, Web browsers, and search engines to sustain the network's operations and management; the Internet is now fully privatized. After

Figure 8-3.

Number of World Wide Web users

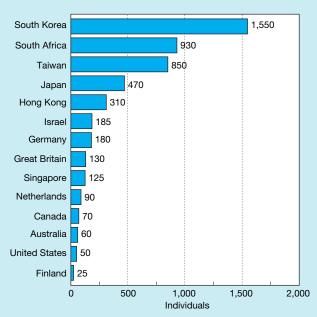


SOURCE: International Data Corporation, "New Priorities and Technologies for the Year Ahead," <http://www.idcresearch.com/BS97/111.htm> (June 1997).

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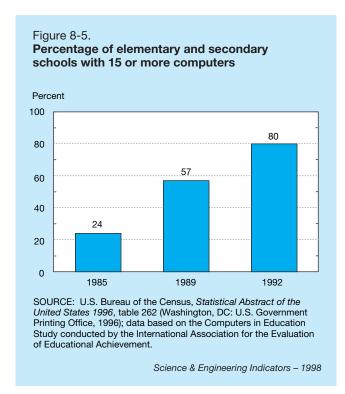
Figure 8-4.

Number of individuals per Internet server, for selected countries: 1996



SOURCE: M. Martin, "When Info Worlds Collide," Fortune October 28, 1996: 130-33. Science & Engineering Indicators – 1998

transforming from ARPANET to NSFNET to the Internet, the next stage of evolution is the "information superhighway"—a telecommunications infrastructure that would allow *all* national public networks and education and research institutions to link with one another at higher speeds than today. Promoted first by the federal National Information Infrastructure Initiative, and now by the Next Generation Internet Initiative, the new information superhighway will be a higher speed, more functional telecommunications network. For more information on the Internet, see Keen (1995) and Cerf (1997).



classroom.⁵ As addressed in the last section of this chapter, educational access to computers and other IT is not equitable in terms of race, ethnicity, or income.

Use of computers in the home lags behind the economic and education sectors. U.S. Bureau of the Census (1993) data indicate that although the number of homes with a computer nearly tripled from 1984 to 1993, this amounted to only 23 percent of all households by 1993. Household use is clearly linked to income and ethnicity. Nearly twice as many adult whites had a computer at home in 1993 as did blacks (27 versus 14 percent, respectively); and 62 percent of all households with incomes of \$75,000 or more had a computer double the rate of households with incomes of \$35,000 to \$49,999 and well over triple the rate of lower income groups. (More detail on the significance of ethnicity and class is discussed later in "Equity Issues.") The comparatively low level of access to home computers in the early 1990s may be changing quickly, however. Data discussed in chapter 7 indicate that 43 percent of adults in a 1997 survey have a computer at home. (See appendix table 7-26.) In addition, a number of PCs priced less than \$1,000 were commercially introduced in 1997, and 80 percent of PC shipments are now expected to be for the home market (Pargh 1997 and IDC 1997).

Determining the social and economic effects of this growing use of IT in society is complicated. First, the scope of such effects—both positive and negative—is immense. For example, over a decade ago, Michael Marien (1986) of the World Future Society compiled and categorized 125 expected

effects of IT, ranging from the individual to the international system. Second, many types of effects are hard to measure—such as productivity in the service sector or the psychological, emotional, and cognitive impacts of prolonged exposure to computing environments. As discussed in the next section, it is easier to measure and develop indicators for the diffusion and uses of IT in society than it is to isolate and examine the consequences of that use.

Issues in Measurement and Research

The measures and indicators used here are unlike those found in other chapters of this volume in several ways. First, data on IT are rarely collected on a systematic basis. Accordingly, there are no extensive time-series data on IT diffusion and its effects—the type of indicators available reflect ad hoc interests rather than ongoing analytical needs. (Two notable exceptions are the time-series data on IT investments and capital stock reported by the U.S. Bureau of Economic Analysis and the data on IT in schools collected by Quality Education Data, Inc.) Second, IT as a concept is not clearly defined, and available data are frequently not comparable. In contrast, such indicators as research and development (R&D) expenditures and scientists and engineers are both well-defined and clearly documented not only in the United States, but in the international community as well.

Third, some subjects of interest have not been quantified, such as labor productivity for several key IT industries, including computing and data services. Fourth, it is often extremely difficult to isolate the effects of IT from other factors, such as industrial deregulation; management practices; employee attitudes; and the myriad conditions affecting student learning and achievement: individual ability, teaching skill, classroom environment, nutrition, affinity for the subject matter, and so on. Fifth, there is a time factor. The effects of a technology on human behavior may take years to show up and often may be reliably detected only through controlled, longitudinal study of a set of individual subjects. Finally, much insight on the effects of IT comes from case studies—a useful form of analysis but one that cannot be used to generalize to a larger group or population.

When new areas of inquiry emerge in the social sciences (such as the social and economic impacts of IT), it can take years to develop a dominant "heuristic" (models, theories, and methods) with which to organize research and empirical findings. The field of study surrounding the social and economic impacts of IT is consequently characterized by the full spectrum of social science research methods and techniques. Research and analyses range from qualitative (the use of historical analysis, guided observation, case studies, pattern matching, metaphors, and other narrative information) to quantitative (controlled experiments, cross-sectional or longitudinal data collection and analysis, survey research, content analysis). In all instances, the objective is to determine patterns of regularities in human behavior and the causes of those patterns.

⁵See U.S. Bureau of the Census (1996), table 262. Data are based on the Computers in Education Study conducted by the International Association for the Evaluation of Educational Achievement.

Two "decision rules" were used when evaluating research for inclusion in this chapter:

- ◆ Diffusion indicators had to be obtained through valid and representative sampling methodologies. In some instances, data from leading market research companies were used, even though detailed information on sampling methods was not available; these firms (such as International Data Corporation) are considered reputable and reliable sources of IT market data.
- Empirical studies had to use valid statistical analysis and sampling methods (when appropriate), control for non-IT factors, and be representative of the group or sector under study. Qualitative studies had to follow an explicit research design and be consistent with other narrative and descriptive information.

Diffusion indicators are relatively abundant because they can be easily obtained through conventional survey methods, and there is considerable commercial interest in the demographics of the IT market. Economic effects have been widely studied, but empirical research frequently tends to result in contradictory findings. Quantitative research on the effects of IT on student achievement is extensive (bibliometric searches yield thousands of citations), but diverse research designs make it extremely difficult to cumulate findings. The educational findings discussed here are the results of "meta-analysis," a technique used for integrating multiple studies (this technique is discussed more in the section on "IT, Education, and Knowledge Creation"). Judgments about the impact of IT on equity and privacy are largely inferred from descriptive data and qualitative analysis because of the difficulties in quantifying political power and levels of individual privacy.

Impacts of IT on the Economy

Diffusion of IT has had significant effects on business activity. Computer-integrated manufacturing, for example, enables automated model changes on the production line as well as fully integrated design and manufacture. Resulting shortened cycle times and the declining significance of economies of scale have led to a competitive environment that focuses on quality, customization, and timeliness of delivery. Firm-level IT networks ("intranets") integrate finance, manufacturing, R&D, operations, and marketing, and have fostered the rise of strategic management in industry. The IT-based integration of producer-supplier and wholesaler-retailer networks enables responsiveness to daily changes in customer demand and a fundamental revolution in inventory management. Advanced telecommunications technologies have integrated international capital markets and literally created a global financial industry. In short, IT has moved economic markets and business behavior far closer to "real-time" mode than has ever existed in the past.

Yet in almost all instances, the precise economic impacts of these effects cannot be quantified, and there is often contradictory evidence about the role of IT. For example, research (reviewed below) shows that IT has contributed to both deskilling and skill upgrading in the workplace, although the trend appears to be toward upgrading. Until very recently, the empirical record demonstrated that, in spite of the enthusiastic adoption of IT by business, IT has had little observable impact on productivity growth in the United States (a paradox explored further below).

This section summarizes quantitative indicators of the economic effects of IT in three core areas of interest:

- the structure of the economy,
- employment and workers, and
- ♦ the "productivity paradox."

The findings indicate that IT has diffused unevenly throughout the economy and that the net impacts on employment and productivity are uncertain—at least as traditionally measured.

Economic Growth and the Service Economy

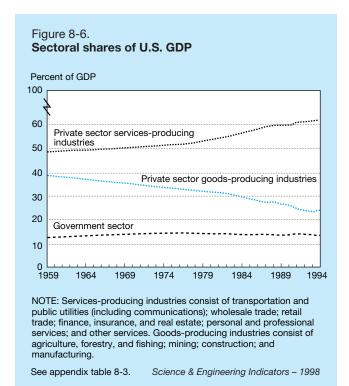
IT contributes to macroeconomic output in a variety of ways. For example, IT can create better ways of generating goods and services, improve production efficiencies, and increase both labor and multifactor productivity. Growth accounting⁶ studies confirm IT's positive impact on total U.S. economic output; estimates of the total contribution of IT to the real U.S. growth rate range from 0.16 to 0.52 percent (Jorgenson and Stiroh 1995, Oliner and Sichel 1994, and Sichel 1997).

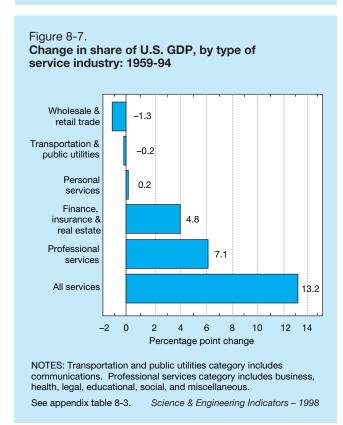
IT is commonly credited as being a key reason for the structural shift from manufacturing to services in the U.S. economy. Rapid growth in existing services, such as banking, and the creation of new industries, such as software engineering, are attributed to the widespread diffusion of IT in the service sector infrastructure (NRC 1994a, and Link and Scott 1998). From 1959 to 1994, the service sector grew from 49 to 62 percent of U.S. gross domestic product (GDP), while manufacturing declined from 28 to 17 percent. (See figure 8-6 and appendix table 8-3.) In the past three decades, growth in services has, on balance, exceeded growth in every other industrial sector—agriculture, mining, construction, and manufacturing.

The expansion of the service sector has been driven entirely by industries that are often classified as "knowledge" industries (see Machlup 1962)—finance, insurance, and real estate (FIRE)—as well as a number of professional services,

⁶Most output and productivity studies use what is known as a "production function" model. The resulting statistics are typically least-squares correlations and estimates based on a log-linear regression. Growth accounting, a technique developed by Denison (1985), principally uses an arithmetic/algebraic procedure on national income accounts data. Robert Solow received the Nobel Prize in economics for his estimates of the contribution of technical change to aggregate productivity using a production function model (Solow 1957). For more detail on these models, see NSB (1996), chapter 8.

⁷Note that these figures differ somewhat from those frequently published; this is because the U.S. Bureau of Economic Analysis recently revised its methodology for calculating the contribution of specific industries to GDP. See U.S. BEA (1996).





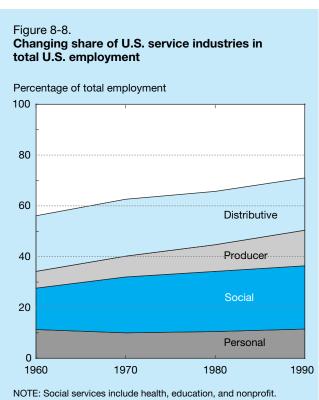
such as health and education. The share of GDP accounted for by wholesale and retail trade actually declined from 1959 to 1994, while personal services and transportation and utilities remained essentially unchanged. (See figure 8-7.) In contrast, FIRE's share of GDP grew by 4.8 percentage points, while that of professional services increased by 7.1 percent-

age points. Employment data reflect the same structural shift in the economy as GDP data. From 1960 to 1990, employment in the service sector grew from one-half to two-thirds of total U.S. employment, with growth strongest in producer services (FIRE and professional services) and social services, particularly health care. (See figure 8-8.)

IT has not, however, been empirically linked in any definitive way to the expansion of the service sector. In a detailed study of several key service industries (banking, insurance, air transport, and telecommunications), the National Research Council concluded that although the benefits of IT for individual industries could be qualitatively described, IT could not be causally linked to gross product output of the individual industry for methodological reasons (NRC 1994a). Two observations are worth making, however. First, based on case study evidence and expert reviews, it is unlikely that the expansion of the air transport, banking, finance, and trade industries would have been as significant in the absence of IT (NRC 1994a). In this sense, IT acted as a technological precondition for growth in many service industries.

Second, IT is unevenly distributed throughout the economy and is particularly concentrated in the service industries that have experienced rapid expansion. This suggests that IT is instrumental to the delivery of many services, and that growth

⁸Specifically, IT investment impacts in the 1980s cannot be isolated from the effects of many market, industry, and economic factors such as the deregulation of banking, telecommunications, and air transport.



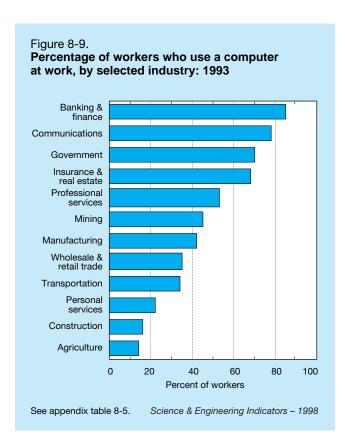
NOTE: Social services include health, education, and nonprofit. Producer services include finance, insurance, real estate, and professional services. Distributive services include transportation, communication, and wholesale and retail trade.

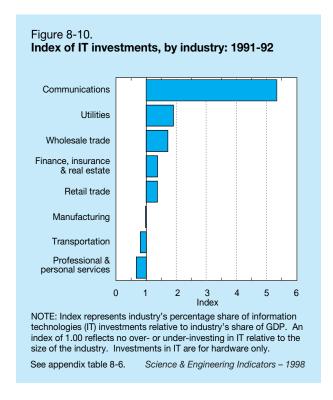
See appendix table 8-4. Science & Engineering Indicators – 1998

in services fuels demand for IT (and vice versa). For example, only 14 percent of workers use computers in agriculture, but 85 percent do so in banking and finance. (See figure 8-9.) Investments in IT similarly vary among industries. For example, the communications industry invests five times as much in IT as would be expected given the size of this sector relative to overall GDP. (See figure 8-10.) The disparity in the relative presence of IT among industries indicates that IT is clearly more critical for some types of business activities than others, and thus may be said to be responsible—in part—for the growth of those industries.

IT and Employment

IT has demonstrable benefits for employment and skill levels, although not unequivocally so. Evidence indicates that IT contributes to growth in demand for labor, as well as an overall skill upgrading in the workplace. Computerization of the workplace appears to have enlarged the wage gap between workers with a college education and those with a high school education or less. With respect to the impact of IT on individual workers' health and emotional well-being, the record is mixed. While the number of IT-related health disorders is clearly on the rise, trends may be in part a socio-psychological phenomenon. Computerized surveillance and monitoring of employees may lead to greater stress and alienation in the workplace, but not necessarily: evidence suggests that IT may increase workers' sense of worth, accomplishment, and job autonomy.





Aggregate Employment

Establishing the net effect of IT on aggregate U.S. employment is difficult for one primary reason: IT is both labor-creating and labor-saving. As new jobs are created in some industries and occupational classes, they are lost in others. For example, banking employment has declined by 100,000 workers since its peak in 1990; analysts attribute this trend in part to the growing use of ATMs (Morisi 1996). IT-driven employment losses are, however, also offset by employment expansion in new industries such as computer and data processing services. Isolating the employment effects of IT from other factors—such as business cycles, industry conditions, and labor mobility—is problematic.

In an evaluation of the research on employment impacts of technology, the National Academy of Sciences concluded that the displacement effects of IT were indeterminate, and depended heavily on conditions in individual firms and industries. Because the nature of the research was so varied and the findings often contradictory, the Academy concluded that

the contrasting results of these studies...illustrate the sensitivity of empirical estimates of the employment impacts of [IT] to detailed assumptions concerning diffusion rates, technological improvement, and the organization of manufacturing and production processes (Cyert and Mowery 1987, p. 292).

Employment trends in key IT-related sectors further illustrate the difficulty of establishing the overall employment effects of a new technology. Employment in IT-producing industries is projected to nearly double from 1986 to 2006. (See text table 8-3.) Yet this trend is driven almost exclusively by growth in computer and data processing services (including prepackaged software), the third fastest growing industry in

Text table 8-3.

Employment in information technology-producing industries
(Thousands)

SIC	code/industry	1986	1996	2006
Total		1,963	2,450	3,778
357	Computer and office equipment	469	363	314
366	Communications equipment	296	269	255
367 737	Electronic components Computer and data	610	610	700
	processing services	588	1,208	2,509

SIC = Standard Industrial Classification

(November 1997).

NOTE: Data are projected based on a moderate growth scenario. SOURCE: U.S. Bureau of Labor Statistics, *Monthly Labor Review*

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terms of employment. Employment in two of the three IT-producing industries has been declining rather steadily since the early 1980s. Thus, trends in one sector mask patterns in another, much the way that the expansionary effects of IT could mask displacement effects within specific industries or occupations (and vice versa). For a discussion of trends in IT occupations see chapter 3, "Science and Engineering Workforce."

Skill Impacts and Wages

Assumptions about the information society and post-industrial economy suggest that the development of IT should increase the demand for workers who manipulate and analyze information relative to the demand for non-knowledge workers or those who simply enter and collate data. Yet there is a persistent popular fear of the deskilling effects of IT, a fear that automation will reduce the demands on an individual's conceptual talents and facility with machinery, equipment, and tools. Individual case studies of specific industries, occupations, and information technologies clearly illustrate that deskilling and skill upgrading take place simultaneously (for reviews, see Attewell and Rule 1994, and Cyert and Mowery 1987). On balance, however, several studies—using different data sets and methodologies—suggest that no overall lessening of skills is occurring in the workforce, and that upgrading may be widespread.

For example, Castells (1996) finds that employment in managerial, professional, and technical classes has been expanding at a rate faster than in non- and semi-skilled occupations. After an extensive review of trends in occupational categories, he concludes that:

The widespread argument concerning the increasing polarization of the occupational structure of the information society does not seem to fit with this data set...I am objecting to the popular image of the information economy as providing an increasing number of low-level service jobs at a disproportionately higher rate than the rate of increase in share of the professional/technical component of the labor force (p. 219).

Howell and Wolff (1993) conclude much the same. Using detailed data on the cognitive and motor skills required for specific occupations from 1959 to 1990, they found that skill restructuring (principally upgrading) in the labor force began in the 1970s and continued in the 1980s in patterns that "are broadly consistent with what one might expect from the rapid expansion of new [information] technology" (p.12). They also found that the demand for the most cognitively skilled information occupations grew more rapidly than for other occupations during some periods. Analyzing data from the Annual Survey of Manufacturers, Berman, Bound, and Griliches (1994) document a significant skill upgrading throughout the manufacturing sector over the 1980s; they attribute the trend in part to computerization of the workplace. Their findings indicate a distinct shift in the demand for labor from less skilled to more highly (cognitively) skilled labor in the United States, a shift that has been linked theoretically and empirically to the diffusion of IT.

Autor, Katz, and Krueger (1997) similarly find evidence that computerization of the workplace may explain from 30 to 50 percent of the additional growth in demand for labor from 1970 to 1995, compared to growth from 1940 to 1970. They find that the increase in the rate of growth for skilled labor since 1970 is driven by rapid skill upgrading in industries that are the most computer-intensive (e.g., those that have the highest levels of computer investment per worker and the largest growth in the proportion of employees who use computers, and those in which computers account for a larger share of total investment). This study finds that those industries that experienced the largest growth in computer use also tended to shift their employee mix from administrative and support workers toward managers and professionals (a finding consistent with Castells 1996). Nonetheless, more systematic insight into which jobs are upgraded (or deskilled), and what happens to individuals whose jobs are deskilled, can provide a better sense of the organizational dynamics surrounding IT and their ultimate employment impacts.

Assumptions about the IT-skill upgrading relationship extend one more step, and also associate wage gaps with computerization in the workplace. Higher wages are attributed to the higher demand for computer-skilled labor, and lower wages are thought to reflect the absence of computer skills (see Bresnahan 1997 for a discussion of this literature). Autor, Katz, and Krueger (1997) support this thesis; as do Berman, Bound, and Griliches (1994).

However, Howell (1997) refutes the argument that skill mismatch is responsible for wage stagnation among less skilled workers by identifying a crucial anomaly in labor market behavior: employment in *low-skill* occupations is declining relative to more highly skilled jobs, but the proportion of *low-wage* workers is actually increasing. Bresnahan (1997) also provides an important critique of the research and empirical evidence on the impact of IT on the demand for skilled labor and wage gaps. He reviews alternative research that indicates that the actual use of IT (particularly PCs) on the job is inconsistent with assumptions about job enrichment,

and concludes that "there is little complementarity between highly skilled workers and PC use, certainly not enough to affect skill demand."

IT and the Worker

While IT may affect the individual worker in any number of ways, two particular effects are worth attention because of their negative physical and psychological aspects: the health hazards associated with the use of IT, and the emotional and behavioral consequences of workplace surveillance and monitoring.

IT is particularly associated with repetitive motion injury, even though a variety of other negative health effects are common, including eyestrain and a complex of musculoskeletal disorders (Huff and Finholt 1994). IT-based repetitive motions include barcode scanning, data entry and keying, and keyboard typing, all of which can lead to carpal tunnel syndrome and tendonitis—sometimes to the point of permanent disability. Data from the Bureau of Labor Statistics (BLS) indicate that the incidence rate of repeated trauma disorder rose from 6.4 per 10,000 FTE (full-time equivalents) in 1986 to 41.1 per 10,000 in 1994. Although the manufacturing sector still accounts for the vast majority of these repetitive motion injuries, the number of repeated trauma disorders increased more than fivefold in the service sector between 1988 and 1992. Grocery stores, newspaper publishing, hospitals, and casualty insurance industries now rank among the 20 sectors with the highest incidence of the disorder, and BLS indicates several other service industries are "poised to enter the list," including airline scheduling, department stores, and mail order retailers (U.S. BLS 1994). The intensive use of IT is clearly an occupational hazard for individuals prone to repetitive motion disorder, but some researchers have found that a number of social and organizational factors can influence both the incidence of IT-related repetitive motion trauma and its severity (Kiesler and Finholt 1994, and Rowe 1994).

Workplace surveillance and monitoring also raise issues concerning workers' psychological health. The U.S. Office of Technology Assessment defined electronic workplace monitoring as "the computerized collection, storage, analysis, and reporting of information about employees' productive activities" (1987, p. 27); and it includes such measures as keystrokes typed per minute, length of time on a phone call, and length of time away from a computer terminal. Workplace monitoring is estimated to have doubled from 20 percent of all office workers in the early 1980s to 40 percent in the early 1990s, and spending on monitoring software is believed to exceed \$1 billion (Aiello 1993).

The effect of workplace monitoring on the individual's well-being and work performance is unclear. One study (Grant, Higgins, and Irving 1994) found that monitored customer service employees believed that good work perfor-

mance was quantity based, while nonmonitored employees focused on the quality of service and teamwork. Another analyst observed workers disconnecting phone calls if it appeared the caller would exceed the 22-second maximum time allotted by the firm to each call (Aiello 1993).

Overall, studies show that workplace monitoring may both increase and decrease productivity, and may or may not lead to greater stress, anxiety, isolation, and diminished work motivation. Actual outcomes depend on a variety of moderating factors in the workplace, including worksite, supervisor style, type and frequency of feedback, and the individual's sense of control over the monitoring itself.¹⁰ Indeed, one study (on the impacts of IT on quality of worklife) concluded that although IT could intensify work pressures, it also enhances workers' sense of worth, accomplishment, and autonomy (Danziger and Kraemer 1986). Van Alstyne (1997) nonetheless regards surveillance and monitoring with suspicion, and concludes that there is good reason to expect that "those suffering reduced autonomy due to IT will seek ways to subvert the system, for example, through sabotage, disuse, delay, use of alternative procedures, supplying inaccurate data, or sticking to the letter but disregarding the intent of the system" (p. 40).

IT and the Productivity Paradox

One of the most debated issues about the impact of IT on the economy is that of the "productivity paradox"—the inability to find a statistical association between IT investments and productivity in the private sector. Despite compelling reasoning and evidence about the highly positive effects of IT on competitiveness and cost reduction, 11 traditional econometric analyses fail to find any productivity benefits for IT, and some studies identify negative productivity impacts for IT investments. The meaning of these findings is subject to considerable debate, with most experts advising caution in interpretation of the data. Problems with measurement and organizational learning lags are two explanations commonly offered to make sense of the counterintuitive empirical findings. However, the most current research on the IT productivity paradox suggests that it may have "disappeared" in the early 1990s; some analysts argue that the paradox is primarily the result of overly optimistic expectations about IT's economic effects.

The Empirical Studies

The IT productivity paradox was revealed by over 20 econometric analyses conducted and published between 1980 and 1990 (for detailed reviews, see Brynjolfsson and Yang 1996, and NRC 1994a). Regardless of the level of analysis chosen—the macroeconomy or specific industries and sectors—these studies demonstrated that there was no

⁹These data are from U.S. BLS's Survey of Occupational Injuries and Illnesses and may be accessed from the Occupational Health and Safety Agency Web site <http://www.osha-slc.gov/ergo/chart3.html>>.

¹⁰For a good overview of these issues and findings, see Aiello (1993).

¹¹See Bender (1986); Benjamin et al. (1984); Harris and Katz (1991); Malone, Yates, and Benjamin (1987); Porter and Millar (1985); Bradley, Hausman, and Nolan (1993); NRC (1994a); and Byrne (1996).

statistically significant, or even measurable, association between investments in IT and productivity.

The findings were troublesome not only because they contradicted strong expectations about positive effects, but also because productivity impacts apparently failed to materialize anywhere (not in services or manufacturing), by any measure (a variety of data sets and methods were used), or at any time (the studies collectively covered the late 1960s to the late 1980s). Findings of positive effects are reported in the literature, but this research represents onetime-only case studies of a single industry or small set of firms. The preponderance of the IT productivity research which incorporates large and relatively comprehensive data sets at the firm, industry, and macro levels—consistently fails to demonstrate a significant positive impact by IT on productivity, regardless of sector or industry. Indeed, one widely cited study finds a negative correlation between investments in IT and multifactor productivity. Furthermore, this study identifies yet another anomaly: industries that are IT-intensive are more profitable than others; but within industries, such intensity is negatively associated with profitability (Morrison and Berndt 1990, and Berndt and Morrison 1995).

Two recent avenues of empirical analysis are, however, notable. Oliner and Sichel (1994) and Sichel (1997) report a small but positive association between IT and productivity using a growth accounting approach. Brynjolfsson and Hitt (1995 and 1996) find large and significant contributions by IT to productivity using a new firm-level database. Both sets of findings are highly suggestive about the nature of the IT productivity paradox. Sichel (1997) argues that it is primarily our expectations that are out of line with the long-term historical trends regarding both IT diffusion and the overall level of IT capital in the economy. Brynjolfsson and Hitt note that a full 50 percent of the variation in IT's contribution to marginal product can be accounted for by firm-level variables. This suggests that aggregate data are not likely to detect patterns in IT impacts, and that the effective use of IT is highly contingent upon the context of its use at the organizational level.

To elaborate, Oliner and Sichel find small but real contributions of computers to the economy. From 1970 to 1992, computer hardware contributed 0.15 percentage points to the total U.S. output growth rate of 2.8 percent. When software and computer-related labor are included, this contribution doubles to 0.31 percentage points for the period 1987 to 1993 (or 11 percent of total growth). Other capital and labor inputs, as well as multifactor productivity gains, account for about 90 percent of the growth in U.S. output during this

period.¹³ The authors explain the small contribution of computers by observing that computing-related inputs are a very small portion of total capital and labor, and have only recently grown large enough to have a measurable impact. They conclude that "computing equipment can be productive at the firm level and yet make little contribution to aggregate growth, precisely because computers remain a relatively minor factor of production" (Oliner and Sichel, p. 286). Sichel (1997) expands on this argument by reflecting on trends in the diffusion of a variety of information technologies. He concludes that computing technologies are part of a 150-year trend toward greater information intensity in the United States, and that we should not expect the effects of computers to be large and sudden, but modest and part of a historical continuum.

Brynjolfsson and Hitt (1996) analyzed the impact of IT on marginal output using a new firm-level database and found large contributions of IT to marginal product for the firms in their study. Every additional dollar of computer capital stock was associated with an increase in marginal output of 81 cents, and every additional dollar spent on IT-related labor was associated with an increase in marginal output of \$2.62. Their earlier work also demonstrates that firm-level factors account for half of the variability in IT's marginal product contributions (Brynjolfsson and Hitt 1995). In contrast, previous studies indicate that increases in IT are not associated with increases in marginal output; Morrison and Berndt (1990) found a negative relationship between IT spending and marginal output.

Several factors may explain the dramatically different findings of Brynjolfsson and Hitt relative to the earlier productivity studies. The later time period of their study (1987-91); the use of a larger data set; more detailed, firm-level¹⁴ data; and the inclusion of IT-related labor (note that IT capital expenses are typically a small fraction of a firm's total IT-related costs) are all reasons why their findings are more positive than those resulting from earlier research. Using similar data and methods, other analysts have also found significant positive rates of return at the firm level, including Lichtenberg (1995) and Link and Scott (1998).

The studies by Oliner and Sichel, and Bryjolfsson and Hitt highlight the complexity of research into the effects of IT on productivity. Both sets of findings suggest that IT does have measurable payoffs for economic productivity, but the orders of magnitude are quite different. Macroeconomic impacts may be quite modest at best (as measured by Oliner and Sichel), whereas firm-level benefits may be more substantial (as measured by Brynjolfsson and Hitt). While they do not indicate

¹²Note that Jorgenson and Stiroh (1995), who also use a growth accounting approach, find an appreciably higher level of contribution by computing hardware to macroeconomic output. These authors estimate that computer hardware contributed 0.38 percentage points to the 2.49 percent growth rate from 1985 to 1992—more than double the 0.15 estimate provided by Oliner and Sichel. Differences are due in large part to the different time periods of the studies and to differing assumptions about depreciation rates. As with other economic analyses, assumptions can have a substantial impact on empirical estimates.

¹³Sichel (1997) asserts that there is no additional contribution of IT hidden in the multifactor productivity (MFP) estimate. MFP is a residual element that reflects technical and organizational changes that improve the efficiency of converting inputs into outputs, hence IT could contribute to gains that are captured by MFP. However, given the nature of growth accounting techniques, IT inputs would have to have a "supernormal" rate of return, and Sichel argues that there is no compelling evidence for such an assumption.

¹⁴Findings are based on a data set of 367 firms generating \$1.8 trillion in aggregate sales in 1991.

that the productivity paradox has been resolved, these findings do suggest that the relationship between IT and productivity may be changing. Explanations for the paradox and the lagged benefits of IT therefore require further exploration.

Explanations for the Paradox

There are a number of interpretations of the productivity paradox, most falling into one of three categories:

- ◆ There is no paradox—IT does have positive effects on business and economic performance, but we are not able to measure these effects easily.
- ◆ The paradox is real but temporary—our social and organizational ability to adapt to new technology lags the pace at which the technology is introduced.
- ◆ The paradox is real and not temporary—the implication of which is that IT has no beneficial consequence for the economy, and hence reflects substantial opportunity costs (that is, money spent on IT is better spent elsewhere).

This third interpretation is not explored in this chapter, since the weight of evidence suggests that there *are* meaningful impacts of IT, challenging measurement problems, and very real social lags.

Excluding disagreements about the quality of various data used in the IT productivity studies (which has implications for sources of error in the findings), there are still a number of core measurement issues. 15 The first is, what constitutes IT? Is it capital investments only, or does it include labor, which represents the bulk of IT operating costs? Do IT capital investments include more than computers, and if so, what? The choices of what to count as an IT equipment expense include computing hardware and software, communications equipment, and a variety of office machines (such as photocopiers and some instruments). At present, there is little consistency among studies, and sources of IT investment data vary from aggregate government data to private survey-based firm data. One fundamental measurement issue is simply standardizing the definition of IT itself (labor, capital, and types of capital): standardized definitions can facilitate data collection, comparability across data sets, and cumulation of findings.

A second key measurement issue is how to assign dollar values to IT as a factor input. IT can be measured as a flow (annual expenses or purchases) or as a stock (the cumulation of equipment over time). In both instances, price deflators are required to compare stocks or flows over time by converting them to "real" dollars. IT equipment is especially problematic for establishing reliable deflators. For example, not only has the sales price of computing equipment been falling rapidly, but because quality has increased exponentially, existing computing stock becomes obsolete very quickly. The pace of technological change in information technologies greatly complicates analysts' abilities to construct quality-

adjusted price deflators¹⁶ and appropriate depreciation rates; distortions in time-series data can significantly affect research outcomes by over- or undervaluing expenses and stocks in different periods.

A third measurement concern relates to output—specifically, how to measure the output of information processing. IT is used extensively for "activities" that do not result in tangible market outputs (e.g., accounting, scheduling, reporting). 17 Consequently, it is difficult to assign a dollar value to the output of IT—a measurement that is crucial to accurate productivity analysis. This measurement challenge is exacerbated in the service sector, where output measures must also capture qualitative differences in services (Mark 1982 and Noyelle 1990); the problem is sufficiently severe that BLS does not report labor productivity for the software industry, a core IT sector (Goodman 1996). The potential for mismeasurement of services and information processing outputs, as well as IT as a factor input, is so troublesome that mismeasurement is usually cited as the primary explanation for the productivity paradox.

A fourth measurement issue deserves attention and has less to do with mismeasurement of a specific indicator (such as factor inputs and product outputs) than of measuring the wrong indicator to begin with. Studies of the applications and use of IT repeatedly demonstrate that IT benefits do not show up as classical efficiency gains, but as cost savings, improved inventory management, and qualitative improvements in customer service. These improvements reflect such dimensions as enhanced timeliness, performance, functionality, flexibility, accuracy, precision, customization, cycle times, variety, and responsiveness regardless of whether the output is a product or service or the consumer is an original equipment manufacturer, a distributor, or an end user (NRC 1994a; Byrne 1996; and Bradley, Hausman, and Nolan 1993). These qualitative dimensions are much more likely to show up as downstream benefits to the consumer (Bresnahan 1986) or as greater competitiveness for a firm—an outcome known as a "distributional effect" (Banker and Kauffman 1988, Baily and Chakrabarti 1988, Brynjolfsson 1993, and Porter and Millar 1985). In addition, Weill (1992) has found that the type of information processing (transaction) matters. In a study of valve manufacturers, data processing could be associated with productivity gains, but general business systems (like sales and marketing support) could not.

Institutional Lags

Another compelling explanation of the productivity paradox argues that it is a real but temporary phenomenon. Sociologists and economic historians have long argued (very cogently) that society's ability to fully exploit a new technol-

¹⁵The measurement problems are substantial and are discussed in detail elsewhere (Bryjolfsson 1993, Baily and Chakrabarti 1988, Griliches 1997, NRC 1994a, and Oliner and Sichel 1994).

¹⁶Note that the issues surrounding the measurement of services and their impacts are comparable to the methodological problems of measuring services and their impacts. Outputs are often intangible, quality is difficult to account for, and constructing R&D-specific price deflators is a complicated task. For more on R&D measurement issues, see NSB (1996), chapter 8.

¹⁷"Activities" are defined as repetitive and structured sets of work tasks; see NRC (1994a).

ogy lags—often by decades—the introduction of the technology itself (Ogburn 1964 and Perez 1983). Similarly, in organizational change scholarship, analyzing institutional resistance to change (technological or otherwise) is the coin of the disciplinary realm. In theory and in practice then, as humans and their institutions become more accustomed to IT, productivity and other aspects of performance should improve.

There is a good deal of evidence to support this argument. Important technological analogies for IT are electric generators and the electric power infrastructure. David (1989) found that it took nearly 20 years for the electric generator—an invention comparable to IT in scope and consequence—to have a measurable effect on industrial productivity; Friedlander (1997) found that historically it has been difficult to measure the benefits of most infrastructure technologies. With respect to IT specifically, firm-level performance can vary considerably, and the effective use of IT is apparently contingent upon a number of moderating variables at the organizational level including strategy, leadership, attitudes, organizational structure, appropriate task and process reengineering, individual and organizational learning, and managerial style and decisionmaking (Cron and Sobol 1983; Curley and Pyburn 1982; Graham 1976; Thurow 1987; Landauer 1995; Tapscott 1996; Danziger and Kraemer 1986; Khosrowpour 1994; Banker, Kauffman, and Mahmood 1993; and Allen and Morton 1994). Other analysts argue that information technologies themselves are the cause of low productivity, since they are not necessarily user-friendly or well-designed. In this respect, evidence suggests that technological adaptation to social need has a lagged effect as well (Eason 1988, Landauer 1995, and Forester 1989).

The productivity paradox may thus be partially explained, but it does not dispel the observation that even as IT is radically changing the nature of some business activity, that activity does not necessarily get translated into greater efficiency or economic welfare. The banking industry is a good case study of the complexity of the paradox, and also of the possibility that the paradox may have "vanished" in the early 1990s for some sectors.

IT and the Banking Industry

The banking industry is one of the oldest users of information technologies—in the early 1950s, Bank of America was the first commercial user of mainframe technology (Morisi 1996). Yet the banking industry reflects most of the empirical dilemmas associated with measuring the impacts of IT: heavy investments in IT; slow (or no) visible improvements in productivity until relatively recently; and impacts that reflect quality improvements, rapid product diversification, and substantial growth in volume of commercial transactions.

IT has clearly changed both the structure and service quality of banking, and appears finally to have a positive impact on cost reduction. But it has taken decades to achieve these results, and traditional productivity analyses still do not de-

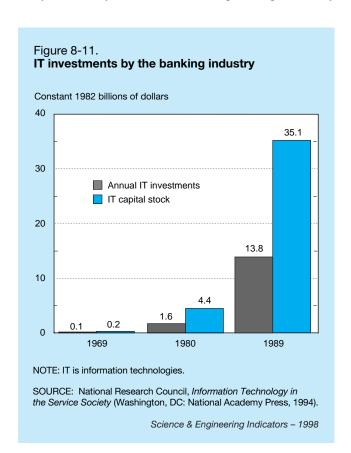
tect positive associations between IT investments and productivity in the commercial banking sector.

Banking industry investments in IT increased substantially from the late 1960s to the late 1980s. (See figure 8-11.) Annual investments in IT (in constant 1982 dollars) grew from \$0.1 billion in 1969 to \$1.6 billion in 1980 to \$13.8 billion in 1989. By 1989, the banking industry was annually investing more funds in IT than were all of the other major service industries except telecommunications. The banking industry invested more in IT relative to its gross product output than the insurance, health care, air transport, telecommunications, wholesale trade, and retail trade industries. (See text table 8-4.)

IT uses are diverse in the banking sector. Initial applications included accounts management and check processing via magnetic ink character recognition. Automated clearing-houses, which enabled electronic funds transfer (EFT), were introduced in the early 1970s and ATMs in the late 1970s. EFT, ATM, and telephone transaction capabilities have replaced a wide variety of paper and in-person transactions in banking, including account deposit and withdrawals, accounts management, credit applications and approvals, cash dispensing, funds transfers, point-of-sale transactions, credit card payments, and consolidation of banking operations.

Impacts on Productivity

Reviews of the traditional econometric productivity literature indicate that IT investments by the banking industry do not systematically result in measurable, positive productivity



Text table 8-4.

Investments in information technologies by selected service industries: 1989

	Investments in constant 1982 dollars	Investments as a percentage of industry gross
Industry	(in billions)	product output
Banking	13.8	19
Telecommunications	13.8	14
Wholesale trade	11.6	4
Retail trade	10.6	3
Insurance	6.2	17
Health care	3.6	2
Air transport	3.0	9

SOURCE: National Research Council, Information Technology in the Service Society (Washington, DC: National Academy Press, 1994).

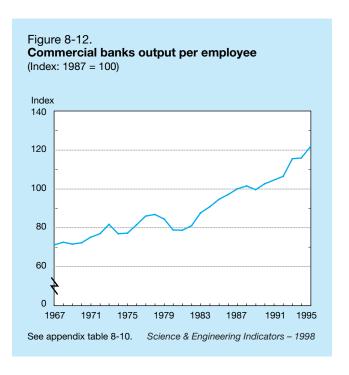
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impacts. Major cross-sector studies (see Brynjolfsson and Yang 1996 for reviews) do not detect positive productivity returns for IT in the banking industry, and Franke's (1989) study of the financial sector (insurance and banking combined) suggests that IT is associated with negative productivity impacts. However, Brand and Duke (1982) do find productivity growth of 1.3 percent per year attributable to computers. Using qualitative evidence and interviews with chief executive officers, the National Research Council attributed the lack of productivity impact to a variety of factors. One is the ever present measurement issue: measures of output in the banking industry are extrapolated from employment data by the U.S. Bureau of Economic Analysis and estimated from indices of financial transactions (loans, deposits, and so forth) by BLS. Neither procedure fully accounts for the volume of banking transactions or wider variety of financial services; the inherent difficulty of measuring commercial banking output seriously qualifies productivity analysis using aggregate data sets.

Note, however, that labor productivity has been steadily improving in the banking industry. (See figure 8-12.) Morisi reports that "during the 1973-93 period, commercial banks had the highest long-term growth in productivity than any of the measured finance and service industries" (1996, p. 30). The difficulty is in empirically linking these improvements to IT.

A second reason for the apparent lack of IT-led productivity growth in this industry relates to problems with early generations of information technologies and organizational adaptation. The National Research Council study reported that:

early applications of IT proved to be costly and cumbersome. Software and equipment had to be updated and replaced frequently...IT systems required large amounts of tailoring, training, upgrading, and updating. Cost control, management skills, and productivity tracking systems lagged behind the new technologies in a rapidly changing competitive marketplace...The result was that tangible paybacks from IT investments were delayed (NRC 1994a, pp. 80-81).



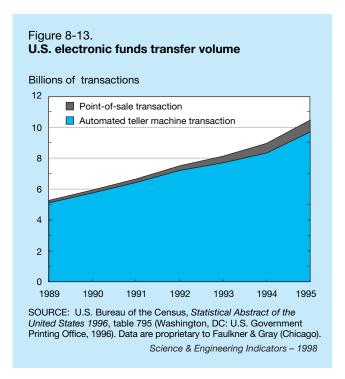
Other Business Impacts of IT

The significance of IT emerges in areas of business impact other than conventionally measured productivity gains. Three types of effects are worth particular note: the expansion of banking products and services, time and cost savings, and competitive positioning.

Banking products and services have proliferated with the use of EFT, ATM, telephone transactions, and automated credit and loan procedures. Banks thus process billions of transactions a year—everything from clearing individual checks, to ATM cash dispersal, to account inquiries, to loan approvals—a volume of interactions that would simply not be possible without automation. For example, the Clearinghouse for Interbank Payment Systems was processing nearly \$2 trillion worth of transactions *per day* by the late 1980s, and Visa's capacity for authorizing credit card transactions increased from 30,000 per day in 1978 to 1.4 million per day in 1991 (NRC 1994a, pp. 83-84). Bresnahan (1986) estimates that the benefits to consumers of the use of mainframe computers for financial services was five times greater than the investments in the computers themselves.

The qualitative improvement in customer convenience, ease, and scope of access to financial resources is reflected in the overall growth of electronic transactions. Figure 8-13 illustrates the expansion of electronic (ATM and point-of-sale) transactions in the United States; the number of electronic cash transactions and payments for goods and services was more than 10 billion in 1995, compared to just over 5 billion in 1989.

Time and cost savings for the industry are also notable. For example, Mellon Bank reduced the average processing time of customer complaints by 20 days when it installed an integrated document system; Visa reduced its processing time for electronic credit card authorizations from 5 minutes in



1973 to 1.1 seconds in 1991; and the Bank of Boston reduced its staff requirements by 17 percent and increased its transaction volume by 80 percent when IT allowed the bank to consolidate its mainframe operations (NRC 1994a, pp. 83-84). The American Bankers Association estimates that ATM transactions cost 27 cents compared to \$1.07 for a human teller, and telephone transactions cost about \$0.35 compared to \$1.82 for a phone call processed by bank personnel (Morisi 1996). In a study of 759 banks, Alpar and Kim (1991) found that a 10 percent increase in IT expenses led to a 1.9 percent decrease in total bank costs.

Although the productivity measures do not find a link between banking industry output and IT investments, it is important to note that while the volume of financial transactions has been increasing at a dramatic rate, employment in the sector has been falling. By 1996, employment in the commercial banking industry was 100,000 employees below its historic peak in 1990. During the same period, the number of ATM transactions doubled to more than 10.5 billion.

IT is of value to the banking industry not only for time savings, cost reductions, and customer services, but for the ability to give individual banks a competitive advantage or the ability to maintain a competitive position. Deregulation of the industry in 1980 led to intense rivalry among institutions, and expanding automated services was one way of attracting depositors and customers. Thus Banker and Kauffman's (1988) study of 508 branch banks found that ATMs were essential to maintaining market share and customer base—not necessarily to reducing costs.

Implications for IT Metrics

The banking industry illustrates many of the issues involved with establishing useful metrics for analyzing the economic

impacts of IT. Not only are there problems with measuring the output of this industry in a meaningful way (productivity estimates require output estimates), but there is the issue of what to measure in the first place. IT clearly provides "value added" in a range of consumer and producer activities that are not captured by productivity analysis, such as convenience, scope of services, access, time savings, transaction volume, and transaction cost reductions. The challenge is to select one or two representative measures of impact and track their performance over time.

The industry may have experienced a long learning curve in terms of adaptation to new information technologies. Insight into how banks reengineered their organizations, management strategies, and work tasks could inform IT strategies in other industries and shorten the lag between the time a technology is introduced and the time it begins to measurably enhance business performance.

IT, Education, and Knowledge Creation

Information technologies are likely to have a substantial impact on the entire spectrum of education by affecting how we learn, what we know, and where we obtain knowledge and information. IT influences everything from the creation of scientifically derived knowledge (see "IT, Research, and Knowledge Creation") to how children learn in schools; lifelong learning by adults; and the storage of a society's cumulative knowledge, history, and culture. Because IT networks create remote sources of instruction and geographically distributed information resources, learning, knowledge generation, and information retrieval are no longer confined to the traditional spaces of laboratories, schools, libraries, and museums.

As a consequence, new education activities such as distance learning are clearly on the rise. ¹⁸ (See chapter 2, "Distance Learning and Its Impact on S&E Education.") In 1984, fewer than 10 states had distance learning facilities, but by 1993 all 50 states did. In the same year, the 20 largest providers of satellite-based instruction purchased 75,000 hours of satellite transponder time; assuming that coursework would be broadcast during a 40-hour week, these top 20 providers purchased the equivalent of 36 instructional years (Katz, Tate, and Weimer 1995). ¹⁹ Internet Distance Education Associates estimates that more than 100 U.S. colleges and universities offer courses over the Internet; ²⁰ National Technical University, a satellite TV educational institution, has over 800 receiver sites (Katz, Tate, and Weimer 1995). Also new are digital

^{18&}quot;Distance learning" refers to education that takes place via electronic means, such as satellite television or the Internet. There is no single organization responsible for certifying or monitoring distance education in the United States, so there are no uniform statistics or a centralized directory of distance learning providers.

¹⁹Note that there are more than 100 major providers of satellite-based instruction.

²⁰Data available from <<http://www.ivu.com>>.

IT, Research, and Knowledge Creation

IT has fundamentally enhanced the conduct of scientific research, data modeling and analysis, and the creation of scientifically derived knowledge. The most pervasive change is the emergence of the "global laboratory"—Internet connections now allow scientists to control instrumentation from a distance, share research findings instantaneously with other scholars around the world, and develop international databases and collaborations. The research applications of networking are extensive (see NRC 1993 and 1994b); IT has gradually eroded the geographic constraints on the conduct of research and knowledge cumulation.

High-speed computing and advanced software applications have also enhanced the analysis of scientific data and drastically shortened the amount of time required to perform certain scientific tasks. For example, data visualization provides dynamic, three-dimensional modeling of complex systems data such as fluid dynamics, while imaging technology provides visual tracking of such minute cellular changes as embryo development. In biology, major advances in rapid gene sequencing and protein mapping are the direct result of highly advanced computational programs (*Science* 1996).

museums, which allow millions of individuals access to history and culture they would not otherwise have. ²¹ These include Fisk University's collection of 7 million African American artifacts; the Vatican's 600-year-old collection of over 1 million books and manuscripts (including the only known copies of many historically significant documents); and the Library of Congress's American Memory Collection of documents, films, photographs, and sound recordings (Memmott 1997). Libraries are undergoing comparably profound digital revolutions (see "IT and the Changing Nature of Libraries").

Because of the growing role of IT in learning and in expanding the scope of educational resources, many people are concerned about the accessibility of information technologies to the nation's schools and the effects of these technologies on students—particularly K-12 children. This section looks at the diffusion of IT in U.S. elementary and secondary schools as well as the effects of computer-based instruction on student achievement. Inequities in student (and household) access to IT are considerable; these are addressed in the final section of this chapter, "IT and the Citizen."

IT also provides knowledge we would not otherwise have—satellite-based technologies are particularly noteworthy. For example, the global positioning system allows geologists to measure precise movements in the earth's crust, thus identifying communities that are vulnerable to earthquakes and aiding in earthquake prediction (Herring 1996). Global climate change modeling similarly owes its advances to satellite-based data collection and transmission; in turn, more detailed knowledge of historical climate patterns has improved our understanding of some infectious diseases and epidemics (Colwell 1996).

Advancement in scientific knowledge is not limited to higher education. An innovative IT-based program includes precollege students from around the world in the research process. The Global Learning and Observations to Benefit the Environment (GLOBE) Program provides environmental science education to K-12 students in more than 3,500 schools and 45 countries. These students collect environmental data for use by the scientific community in research on the dynamics of the earth's global environment. Students report data on the Web, generate graphical displays and contour maps, and interact with international research scientists as well as other GLOBE students (Finarelli n.d.).

IT and Precollege Education

National pressures to increase the scope and use of information technologies in U.S. elementary and secondary schools are persistent (PCAST 1997, NIIAC 1995, The Children's Partnership 1996, and McKinsey and Company 1995). In most instances, the primary reason for greater emphasis on IT is adequate job training, although there is notable concern over avoiding a stratified society in which the "information haves" are divided from the "information have-nots." Greater use of IT at the precollege level is frequently understood as the training students need to be competent members of the information society and to enjoy an information-enhanced quality of life.

Assumptions about the educational, employment, and life-enhancing benefits of IT are not universal, however. *Silicon Snake Oil: Second Thoughts on the Information Highway* by Clifford Stoll (1995) represents one popularized critique of claims about the social payoff of IT (including educational benefits). Additionally, scholar Larry Cuban (1994) has repeatedly raised the question "should computers be used in classrooms?"; and journalist Todd Oppenheimer (1997) has explored the significant educational opportunity costs that may emerge with greater spending on IT. The fundamental dilemma of computer-based instruction and other IT-based educational technologies is that their cost effectiveness compared to other forms of instruction—for example, smaller class sizes, self-paced learning, peer teaching, small group learning, innovative curricula, and in-class tutors—has never been

²¹This "digitizing of history"—particularly that of perishable or fragile photographs, artwork, documents, recordings, films, and artifacts—represents a socially invaluable preservation function and allows people to view items that could never be displayed publicly. Note that the Library of Congress Web site <<ht>http://www.loc.gov>> had over 42 million hits in April 1997 alone (Memmott 1997).

IT and the Changing Nature of Libraries

Historically, the public library has played a central role as an information resource in American communities. Gallup polls indicate that the majority of American adults still regard the public library as a key center for educational support, independent learning, research, community information, and reference resources (NRC 1994b). Not surprisingly, the United States has the most extensive public library system in the world, and more than one-half of the adult population and three-quarters of adolescent children use public libraries.

With the advent of new information technologies, the nature of library information resources is changing. Electronic information services are increasingly common; and CD-ROM databases, remote database searching, and on-line catalogs are available in more than two-thirds of the U.S. public libraries that service communities of 100,000 or more individuals. Networks allow libraries to leverage their resources through interlibrary loans and have stimulated the development of the "digital library," a concept that reflects the digitization of library resources and collections. The ability to store and transmit mixedmedia resources (see the text discussion of digitized museums) gives greater significance to nonprint information resources (such as sound recordings and visual images) and has stimulated librarians to expand and diversify their information management skills. Stewardship of library information has moved from a "just-in-case" model of on-site materials to a "just-intime" model of resource access and sharing.

The Internet has significantly expanded the resource base of public libraries. Library-based access provides a number of advantages to Americans. First, it is an affordable, equitable, and ubiquitous point of access for most individuals. Second, locally developed databases and network linkages are highly responsive to the needs of the local community and can facilitate more effective network use. Third, the library can act as an electronic gateway to information for people who would not otherwise have access to the Internet.

Barriers to library connectivity exist, as evidenced by the relatively low level of library linkage to the Internet. Less than half of public libraries (45 percent) were connected to the Internet in 1996, a figure that masks considerable variation by community size: less than one-third of libraries in communities of less than 5,000 individuals had Internet access (31 percent), compared to the 82 percent of libraries serving metropolitan areas over 1 million people. For the roughly 500 libraries that serve metropolitan areas of 100,000 or more, 93

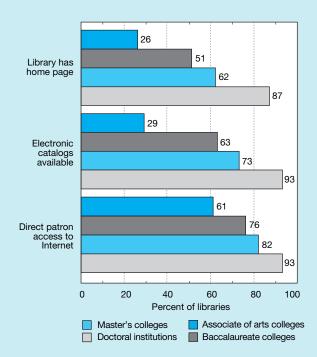
percent offer Internet access to the library staff, and one-half offer access directly to patrons (ALA 1996). As access fees decline, it is likely that more libraries will connect to the Internet: representatives of more than 70 percent of those libraries not now connected say they plan to do so within the next year (ALA 1996).

In contrast, academic libraries are highly "wired," but with variations by type of institution. Associates degree colleges lag other institutions of higher education on most dimensions of electronic access to resources, including direct patron access to the Internet, the availability of electronic catalogs, and the library's development of its own home page for students. (See figure 8-14.)

For more information on the substantial changes in library activities related to the use of IT, see NRC (1994b), Lyman (1996), and Lesk (1997).

Figure 8-14.

Academic library access to electronic resources: 1996



SOURCE: American Library Association, "How Many Libraries Are on the Internet?," LARC Fact Sheet No. 26 << http://www.ala.org/library/fact26.html>> (1996).

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proven (Rosenberg 1997, Cuban 1994, and Kulik and Kulik 1991). Although real IT learning benefits have been measured and demonstrated, whether the magnitude of these benefits is sufficiently large to justify limiting other school curricula and programs is open to question.

The budget issues and educational opportunity costs associated with IT are not trivial. In a report to the U.S. Advisory Committee on the National Information Infrastructure, McKinsey and Company (1995) estimated that about 1.3 percent of the national school budget is spent on instructional technology. Heightening the level of IT in K-12 public schools would require raising this share to as much as 3.9 percent, depending on the degree of IT intensity desired.²² This spending increase is for hardware only, and does not include IT operational expenses or the cost of teacher training, a significant factor in the effectiveness of computer-based instruction (U.S. OTA 1995, McKinsey and Company 1995, Ryan 1991, and PCAST 1997). Yet inflation and the expanding school-age population account for almost all growth in school budgets; the McKinsey report states that only 1.6 percent of the growth in per student expenditures is available for IT and other discretionary spending, including building repair and maintenance, school security, teacher salaries, and the operating costs of IT hardware. Because school districts are under increasing fiscal stress, expanding IT resources could mean cutting other important programs. Oppenheimer (1997) details sacrifices in art, music, physical education, vocational trade ("shop") classes, and textbook purchases that have been made for computers. The negative impacts of these sacrifices on learning and job skills are not usually considered in the growing emphasis on CBI. Also not considered is the potential decline of "collateral" and experiential learning that may occur as more instruction is shifted to the computer (Cuban 1994).

Our understanding of the learning impacts of CBI is primitive. The research reported below does find systematically positive learning benefits associated with computer use in schools, but the magnitude of the benefits is often modest and varies by level of education, characteristics of the learners, characteristics of the instruction and teachers, subject matter, and type of computer application. CBI is a broad category that captures computer-assisted instruction (typically drill-and-practice exercises or tutorial instruction), computer-managed instruction (the computer monitors student performance and progress and guides student use of instructional materials), and computer-enriched instruction (the computer functions as a problem-solving tool). Categories of software use are even more extensive and include generic information-handling tools, real-time data acquisition, simulations,

multimedia, educational games, cognitive tools, intelligent tutors, construction environments, virtual communities, information access environments, information construction environments, and computer-aided instruction (Rubin 1996). Software (courseware) for inquiry-based learning²³—the ultimate goal of most CBI advocates and the most cognitively demanding form of learning—is in short supply. This resource deficiency may be one cause of the limited measurable impacts of CBI on higher order thinking skills and learning (Kulik and Kulik 1991, PCAST 1997, and McKinsey and Company 1995).

Research data suggest that CBI appears to be most effective with rote learning at the elementary school level and in special education settings (that is, in remedial work, or with low achievers or those with learning disabilities). The impact of CBI on critical thinking and synthesis skills is much harder to demonstrate. Also unclear is how to maximize the effectiveness of CBI in the classroom: empirical studies often account for 40 or more contextual variables related to learning and instruction. Schofield (1995) sheds light on this contextual complexity of computers and learning in her detailed twoyear case study of computer use at a typical urban high school. Her findings demonstrate how the social organization of the school and classrooms affect computer-related learning, behavior, attitudes, and outcomes. On balance, Schofield found that computers aggravated pre-existing differences between academically advanced and "regular" students, boys and girls, and college-bound and non-college-bound students.

Computer-based instruction clearly does not take place in a vacuum, but systematic understanding of the social and cognitive complexity of computer-based learning is limited. As the President's Committee of Advisors on Science and Technology, Panel on Educational Technology, concluded,

Funding levels for educational research have been alarmingly low...In 1995, less than 0.1 percent of our nation's expenditures for elementary and secondary education were invested to determine which educational techniques actually work, and to find ways to improve them (PCAST 1997).

Diffusion of IT in K-12 Education

Over the past 20 years, computers and other information technologies have been diffused widely in the U.S. K-12 educational system. Ninety-eight percent of all schools have at least 1 microcomputer for instructional use, and about 80 percent have 15 or more (see figure 8-5 earlier in this chapter). One-half of a school's instructional computers are located in the classroom, 37 percent are located in computer labs, and approximately 13 percent are placed in other public

²²For example, ensuring adequate pupil-to-computer ratios and Internet connections to the school versus universal classroom deployment of full multimedia computers, Internet connections, and school networks. The McKinsey report details three alternative IT models and estimated costs.

²³Inquiry-based learning represents active learning on the part of a student rather than the passive assimilation of information "taught" by an instructor. Inquiry-based learning reflects active construction of models for conceptual understanding, the ability to connect knowledge to the world outside of the classroom, self-reflection about one's own learning style, and a cultivated sense of curiosity. See Rubin (1996).

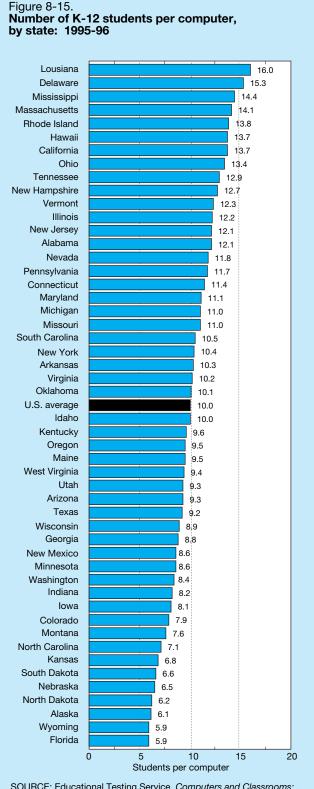
access rooms such as a library or media center. This distribution has not changed since the mid-1980s.²⁴

Estimates of the average number of computers per pupil in the early 1980s vary widely—from 42 to 125 students per computer; but data consistently indicate that the ratio now is approximately 10 or 11 students per computer (ETS 1997).²⁵ Disparities in student access are considerable, however. The differences in students per computer by state of residence range from about 6 pupils per computer in Florida to 16 in Louisiana. (See figure 8-15.)

Schools have also adopted other information technologies. For example, in 1996, 85 percent of schools had access to multimedia computers, 64 percent had Internet access, and 19 percent had satellite connections. (See figure 8-16.) Diffusion of these additional information technologies has been quite rapid. In 1992, only 8 percent of schools had an interactive videodisk, compared to 35 percent in 1995; 5 percent of schools had local area networks, compared to 38 percent in 1995; and only 1 percent had satellite dishes, compared to 19 percent in 1995. (See appendix table 8-7.)

School access to these technologies does not necessarily mean that they are used for instructional purposes, however. The National Center for Education Statistics reported that 65 percent of all public schools had Internet access in 1996, but only 14 percent of school rooms actually used for instruction were linked to the Internet (NCES 1997).²⁶ On a state-by-state basis, the number of schools with Internet access varies far more than the student-to-computer ratios. (See figure 8-17.)

A 1992 survey of elementary and high school principals indicates that the three most important reasons schools adopt computer technologies are to (1) give students the experience they will need with computers for the future, (2) keep the curriculum and teaching methods current, and (3) improve student achievement (Pelgrum, Janssen, and Plomp 1993). There are, however, notable differences in the ways in which computers are actually used: the higher the school grade, the more computers are used for computer training and the less they are used for teaching academic content. At the fifth grade level, 58 percent of CBI time relates to subject matter, and only 32 percent relates to computer skills such as word processing and spreadsheets. By 11th grade, more CBI time is spent on computer skills (51 percent) than academics (43 percent); instructional use for math and English drops from 35 to 14 percent.²⁷ (See text table 8-5.)



SOURCE: Educational Testing Service, Computers and Classrooms: The Status of Technology in US Schools, Policy Information Report (Princeton: Educational Testing Service, Policy Information Center, 1997).

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²⁴See U.S. Bureau of the Census (1996), table 262; these data are based on the Computers in Education Study conducted by the International Association for the Evaluation of Educational Achievement (see IEA n.d.).

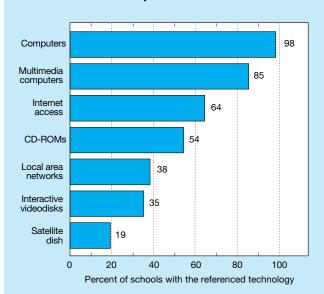
²⁵See also U.S. Bureau of the Census (1996), table 261 (based on unpublished data from Market Data Retrieval), and table 262 (based on IEA n.d.).

²⁶There were also significant differences in Internet access based on minority enrollment. See chapter 1, figure 1-17 and related discussion, and appendix table 1-25.

²⁷The President's Committee of Advisors on Science and Technology has recommended that the primary focus of computer-based instruction be content-oriented rather than skills training. See PCAST (1997).

Figure 8-16.

Diffusion of IT in U.S. public schools: 1996



NOTE: IT is information technologies.

SOURCE: Educational Testing Service, Computers and Classrooms: The Status of Technology in US Schools, Policy Information Report (Princeton: Educational Testing Service, Policy Information Center, 1997).

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Text table 8-5.
Instructional use of computers in K-12 education: 1992
(Percentages)

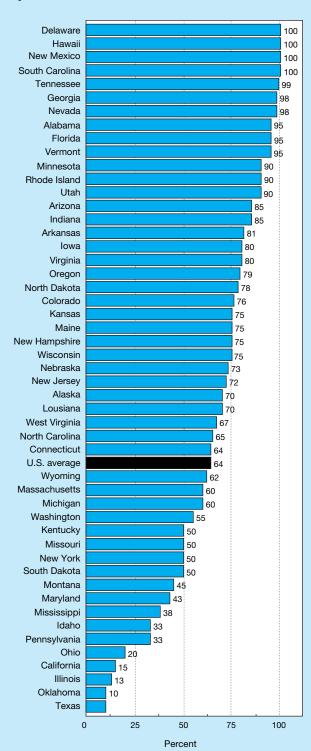
Type of use	Total	Grade 5	Grade 8	Grade 11
Total student use	100	100	100	100
Academic subjects	51	58	44	43
Mathematics	15	18	12	7
English	13	17	10	7
Science	7	8	7	6
Social studies	7	9	6	3
Business education	4	3	3	10
Industrial arts	2	1	3	6
Fine arts	2	2	2	2
Foreign languages	1	-	1	2
Computer training	39	32	46	51
Word processing	14	12	16	17
Keyboarding	14	13	15	14
Programming	5	3	7	8
Spreadsheets	6	4	8	12
Recreational use	9	10	10	6
Other	1	1	1	-

SOURCE: U.S. Bureau of the Census, Statistical Abstract of the United States 1996, table 262 (Washington, DC: U.S. Governent Printing Office, 1996); based on the Computers in Education Study conducted by the International Association for the Evaluation of Educational Achievement.

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Figure 8-17.

Percentage of K-12 schools with Internet access, by state: 1996



SOURCE: Educational Testing Service, *Computers and Classrooms: The Status of Technology in US Schools, Policy Information Report* (Princeton: Educational Testing Service, Policy Information Center, 1997).

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Impacts of IT on K-12 Student Learning

A keyword search of ERIC, the primary bibliometric database used for educational research, yields thousands of citations related to computer-assisted instruction and student achievement. The signal characteristic of this research is its seeming lack of comparability: studies range from anecdotal reports to formal experimental designs, many of which control for different sets of variables and include different types of computer use in different subject areas. Moreover, interest in the effects of computers on young people is not limited to learning and achievement. Concerns about the emotional and psychological effects of prolonged exposure to computing environments have also been raised. (See "Children, Computers, and Cyberspace.")

One way of integrating disparate research is with "metaanalysis," a statistical technique used in the field of education and other disciplines.²⁸ Meta-analysis provides a way of standardizing the statistical results of quantitative research so that multiple studies can be compared in a reliable manner. About a dozen meta-analyses have been conducted on the effects of computer-based instruction, all of which find positive (though not necessarily large) learning effects. The magnitude of learning effects varies across a host of conditions, including type of instruction, subject matter, duration of the experimental treatment, and degree of teacher training. Detailed information on meta-analysis as an integrating methodology is presented here, as are two meta-analyses of the impacts of CBI on precollege learning. These studies illustrate the methodology of meta-analysis, the resulting metrics, and the interpretation of such metrics.

Children, Computers, and Cyberspace

Education scholar Larry Cuban once remarked that "if the full influence, both positive and negative, of television watching on children continues to be debated three decades after its introduction, how can anyone assess the complexity of what happens to children using classroom computers?" (1994, p. 537).

The comparison to television is pertinent, since many of the concerns raised about children, computers, and the Internet are similar to those raised in the past for TV. Of particular concern is the psychological and emotional wellbeing of children. Cyberspace brings its own set of potential dangers to children, including cyberhate and cyberporn—forms of adult expression that children might not be able to handle.

The extent of the problem—the access by children to age-inappropriate materials on the Internet—is debated intensely. The ease with which children may access sexually explicit materials is disputed (see Gay 1996), but congressional testimony (U.S. Senate 1995) and case studies (Turkle 1995) reveal that young people can easily obtain graphic sexual photographs and engage in "netsex" on the Internet; one young teen also reported being electronically stalked by an adult who clearly knew she was a minor.

The primary legislative effort to protect children on the Internet was the Communications Decency Act of 1996, a law that made providing "indecent" material to minors over the Internet a crime. The act was declared unconstitutional by the Supreme Court in 1997 (*Reno v. American Civil Liberties Union*) for a variety of reasons, including the fact that indecent material has consistently been protected as a form of free speech in the United States. (The Supreme Court has historically made a distinction between

indecent and obscene material; obscenity is not protected under the First Amendment.) Limiting children's access to inappropriate materials has now become a technological challenge, relying on such filtering software as Cyber PatrolTM and CYBERsitterTM. Adult verification systems such as Adult CheckTM also are becoming more common. Note that children's vulnerability is not limited to sexually explicit materials; parental concerns have also been raised with regard to Internet violence, hate speech, deceptive advertising, "false front" Web sites, and exploitation of children's privacy.

Concerns about core psychological processes—such as self-identity—have also been examined. Sherry Turkle, a behavioral scientist who studies the impact of early and prolonged use of computing environments on children, has uncovered patterns that suggest the computer culture is not benign. Computing and cyberspace may blur children's ability to separate the living from the inanimate, contribute to escapism and emotional detachment, stunt the development of a sense of personal security, and create a hyper-fluid sense of identity (Turkle 1984 and 1995).

While there may be psychological benefits associated with computer-mediated reality (including greater empathy for those of different cultures, sex, or ethnicity; heightened adaptability; and a more flexible outlook on life), the "darker side" of the technology is nonetheless unsettling. Turkle raises the possibility that extensive interaction with cyberspace (especially through multi-user domains) may create individuals incapable of dealing with the messiness of reality, the needs of community building, and the demands of personal commitments (Turkle 1995).

²⁸Detailed reviews of the meta-analytic technique may be found in Hittleman and Simon (1997); Kulik and Kulik (1991); Ryan (1991); McNeil and Nelson (1990); and Glass, McGaw, and Smith (1981).

Meta-Analysis

Meta-analysis is a method for combining the statistical results of research studies that test the same general hypothesis and use the same statistical measures. Meta-analysis related to CBI focuses primarily on the impact of computer usage on student learning, although other educational outcomes may be studied (such as attitudes toward computers, attitudes toward school subjects, and amount of time needed for instruction).

As discussed here, meta-analysis yields a standardized metric called an "effect size." Effect size is a score that measures the difference in performance between experimental and control groups. For CBI, effect size is based on the performance of control and experimental groups on a common examination. As a metric, effect size is expressed as a proportion of standard deviation (a z-score) and has a percentile equivalent; it also controls for the influence of sample size.²⁹ The z-score reflects how much better (or worse) the experimental group performed on an exam relative to the mean of the control group. Examples of effect sizes and their interpretation are provided below in the discussion of specific meta-analytic research.

Meta-analysis is valuable for two key reasons. First, it allows researchers to cumulate and integrate the findings of multiple studies (particularly those that are small in size) into a single measure of outcome. Second, it estimates a specific magnitude for an independent variable's impact. Other methods that aggregate diverse studies, such as "tallies" and "box scores," indicate overall patterns and trends in research findings but do not estimate the degree of influence of one variable on another.

Meta-analysis has a number of potential weaknesses, however. First, biased or flawed studies, when cumulated, will generate biased or flawed meta-analysis. Second, for some types of meta-analysis, aggregative data can lead to "Simpson's Paradox"—an outcome in which the statistics indicate a relationship opposite to what is actually occurring. Simpson's Paradox is most likely to occur with the aggregation of categorical data, such as that of risk assessment (see Utts 1996). Third, the results of meta-analysis are point estimates; that is, they are single numeric values (z-scores) without reference to a confidence interval or some estimate of the precision of the estimates themselves. As a consequence, meta-analysis z-scores reflect a level of unmeasured uncertainty.

Meta-analysis therefore relies upon rigorous research designs to avoid potential pitfalls. Two factors affect the overall quality of a meta-analytic study (Hittleman and Simon 1997, and Utts 1996). One factor is the decision about what primary research to include in the synthesis. Ideally, only research that reflects experimental and quasi-experimental design should be used; target groups should contain large numbers (typically 20 or more units of observation); data on means, standard deviations, and sample sizes should be reported; and

methodologically flawed studies should be eliminated from the analysis. In this way, only the most rigorous studies are included for synthesis. Second, because meta-analysis must account for a large number of other factors that can potentially affect the dependent variable, coding of these additional factors must be particularly precise and consistent. As a consequence, the meta-analysis research design must contain provisions for checking intra- and/or inter-coder reliability. The two studies reported below conform to the general requirements for proper meta-analysis and avoid the most common pitfalls associated with this type of research.

Meta-Analyses of Computer-Based Instruction

In general, traditional literature reviews and box-score tallies of computer-based instruction research indicate positive effects. CBI appears to result in some degree of observable achievement effect most of the time, but not always. Metaanalyses try to quantify precisely the magnitude of these effects; over a dozen meta-analyses of CBI covering precollege and postsecondary education have been conducted.³⁰ Three observations are worth noting here.

- ◆ In their review of 11 meta-analyses, Niemiec and Walberg (1987) find evidence that effect sizes for high school and college tend to be smaller than for elementary school and students with special learning needs.
- ♦ There is systematic evidence that CBI effect sizes are higher in the published literature than in unpublished documents such as dissertations, conference papers, technical reports, and professional presentations. Meta-analyses must consequently include nonpublished research findings to avoid overly positive estimates of the impact of CBI on student learning.³¹ The two meta-analyses discussed in detail here (Kulik and Kulik 1991, and Ryan 1991) take care to include a variety of nonpublished literature in their syntheses.
- ◆ The meta-analyses conducted to date cover CBI only from the late 1960s to the mid- to late 1980s. Therefore, these studies do not reflect the substantial changes in computer hardware, educational software, teacher preparedness, and styles of computer-based teaching and learning that may have occurred in the 1990s.

Kulik and Kulik (1991) performed a meta-analysis on 254 studies conducted between 1966 and 1986. The CBI effectiveness studies included in the meta-analysis reflect (1) all levels of education—precollege and postsecondary, (2) controlled evaluations³² in real classroom settings, not laboratories; and (3) research free from a number of methodological

²⁹Studies with small sample size tend to have large statistical variance, while large studies have smaller variance. Meta-analysis controls for variance and provides greater weight to the results of large studies, which tend to be more statistically robust.

³⁰Niemiec and Walberg (1987) identify 11 such studies; more recent metaanalyses include Kulik and Kulik (1991), Ryan (1991), and McNeil and Nelson (1990).

³¹This is not necessarily problematic. Bibliometric databases in the field of education include dissertations, technical reports, and unpublished conference papers.

³²For example, two courses teach the same subject matter, but one course uses CBI (the experimental or treatment group) and one course uses conventional instruction (the control group). At the end of the treatment period, students are given the same test and test performance is compared.

flaws specified by the authors. Even though the studies themselves reflect controlled research designs, they often capture different contextual factors. As a consequence, Kulik and Kulik coded a large set of "control" variables that might affect learning outcomes, such as the type of computer application, the instructor, and course content. (See text table 8-6.)

Although the Kulik and Kulik study synthesized findings for several educational levels, many findings for K-12 CBI were reported separately. Two examples and interpretations of K-12 effect size from this study are presented here. In the first example, the overall effect size for 68 studies on computer-assisted instruction at the precollege level was 0.36. Because effect size is a standardized value based on the normal distribution and standard deviation, it can be interpreted as a z-score and converted to a percentile equivalent. A z-score of 0.36 is equivalent to the 64th percentile; students using CBI scored (on average) in the 64th percentile on measures of learning and achievement compared to the 50th percentile for students in a traditionally taught class.³³

Obviously, factors other than CBI could have influenced these learning outcomes. Of the nine major categories of variables that Kulik and Kulik evaluated as alternative predictors of effect size, four were statistically significant influences: the type of application, the duration of instruction, the year of research publication, and the publication status of the research.³⁴ Effect sizes were systematically higher for:

- ◆ computer-assisted instruction (as opposed to computermanaged or computer-enriched instruction),
- instruction periods of four weeks or less in duration,
- reports published before 1970, and
- published research.

These findings are somewhat suggestive, since they indicate that (1) some types of CBI may be more effective than others (at least given existing courseware), (2) learning effects may diminish when computers are used for long periods, (3) there may be "novelty" learning effects associated

Text table 8-6.

Typical study features accounted for in computer-based instruction meta-analyses

Kulik and Kulik	Ryan

Type of application

(computer-assisted instruction, computer-managed instruction, computer-enriched instruction)

Duration of instruction

(four weeks or less, more than four weeks)

Type of computer interaction

(off-line, terminal with mainframe, microcomputer)

Subject assignment to study groups

(random, nonrandom quasi-experimental design)

Instructor effects

(same instructor for experimental and control groups, different instructors for experimental and control groups)

Test bias

(commercial standardized test, locally developed test)

Course content

(mathematics, science, social science, reading and language, combined subjects, vocational training, other)

Year of reporta

Source of study findings

(e.g., technical report, dissertation, article, book, etc.)

Student features

(grade level, socioeconomic status, school type, school area, ability level)

Computer hardware

(computer make, color monitor, music and sound, synthesized speech, input devices)

Software

(subject area, source, type of application—e.g., drill and practice, simulation, tutorial)

Size of instructional unit

Physical setting

(type of communication, type of room)

Duration of instruction

(duration of treatment, length of sessions, frequency of sessions)

Instructor features

(professional level, hours of pretraining)

Methodological features

(subject assignment, instructor effects, test-author bias)

Year of report^a

Source of study findings

(e.g., technical report, dissertation, article, book, etc.)

^aYear of report can be used as a proxy for the age, or "vintage," of the computer equipment.

SOURCES: C.-L. Kulik and J.A. Kulik, "Effectiveness of Computer-Based Instruction: An Updated Analysis," *Computers in Human Behavior*, Vol. 7 (1991): 75-94; and A. Ryan, "Meta-Analysis of Achievement Effects of Microcomputer Applications in Elementary Schools," *Educational Administration Quarterly*, Vol. 27, No. 2 (May): 161-84.

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³³Note that students in a conventionally taught course are the control group. Assuming a normal distribution of test scores, the average test score (the mean) of this group represents the 50th percentile: one-half of all students score above the mean, and one-half score below the mean. The z-score that corresponds to the mean of a normal distribution is zero, so the effect of CBI would be zero because it is not used in the control group.

³⁴Statistical significance means that the average response (e.g., test score) is distinctly different between the groups in question. Tests of statistical significance are based on probability theory.

with computer use,³⁵ and (4) not all CBI has a demonstrable achievement effect.

As a second example of meta-analysis, effect sizes for specific academic subjects varied from 0.10 for science (54th percentile), 0.25 for reading and language (60th percentile), and 0.37 for mathematics (64th percentile). Although it may be tempting to conclude from these metrics that CBI is more effective for mathematics than other subjects, these subject matter differences in effect size were not statistically significant in the meta-analysis.

When presented as percentile equivalents or as fractions of a standard deviation, gains in computer-assisted instruction appear modest. Another way of interpreting meta-analysis effect size is as grade-equivalent scores, which provide a more concrete sense of impact (Ryan 1991). Glass, McGaw, and Smith (1981) report that in elementary school grade levels, the standard deviation on most achievement tests is the equivalent of one grade level. As a consequence, a 0.36 effect size, which is equivalent to 0.36 standard deviations, represents a gain of about 3 to 4 months of instruction, assuming the school year is about 9 to 10 months long. This indicates that about three to four months' more learning occurred than could generally be expected in a school year. However, because the Kulik and Kulik effect sizes reported above are for both elementary and secondary schools, they cannot be interpreted in grade-equivalent gains.

Ryan's (1991) meta-analysis of the effects of microcomputers on kindergarten through sixth grade achievement can be reported on a grade-equivalent basis. Her meta-analysis of 40 studies³⁶ conducted between 1984 and 1989 found an overall effect size of 0.309. Thus, the average K-6 student using a microcomputer as an instructional tool performed in the 62nd percentile on tests, compared to the 50th percentile for the average K-6 student who did not use a microcomputer. Ryan explains that

the effect size of .309 means that the effect of computer instruction is approximately one-third greater than the effect of control group instruction. In terms of grade-equivalent units, .309 can be interpreted as one third greater than the expected gain in a school year, approximately 3 months additional gain in [grade level]" (p. 171).

Ryan likewise evaluated several sets of variables other than CBI that may have had an impact on effect size. (See text table 8-6.) Of these variables, only the degree of teacher pretraining was statistically significant. In experimental groups where teachers had fewer than 10 hours of computer pretraining, the effect size of CBI was negligible and, in some instances, negative. In groups where teacher pretraining ex-

ceeded 10 hours, the effect size was 0.53, equivalent to onehalf a school year gain, or 70th percentile performance. Ryan's findings reinforce other studies that identify the crucial role of teacher preparedness in effective CBI (U.S. OTA 1995 and PCAST 1997).

Computers and Alternative Instruction

Computer-based instruction can also be incorporated into enriched learning environments. Isolating the effects of computers in these alternative approaches to education is difficult, but the positive impacts of the full instructional package for several special projects merit note. One is the Higher Order Thinking Skills (HOTS) Program, an intervention program for economically disadvantaged students in the fourth through seventh grades. Students were taken from their traditional classrooms and taught through an innovative curriculum that integrated computer-assisted instruction, drama, and Socratic method. Students in the HOTS Program outperformed other disadvantaged students in a control group on all measures and had double the national average gains on standardized tests in reading and mathematics (Costa and Liebmann 1997). The Buddy Project in Indiana, in which students in some classrooms were given home computers, also reported highly positive results across a variety of skills. Similar results were reported for the Computers Helping Instruction and Learning Development in Florida, an elementary school program that emphasized student empowerment, teacher training and teamwork, and independent learning (ETS 1997). These studies suggest that the use of computers in enriched, nontraditional learning environments might achieve the fundamental changes in student learning that advocates of computer-based instruction desire.

IT and the Citizen

Access to information and proficiency with information technologies could potentially influence an individual's well-being. Employability and income are tied increasingly to computer training and literacy, and a home computer could enable families to change their work patterns through telecommuting. (See "Trends in Telecommuting.") Because of the rapidly expanding variety of services offered on the Internet and World Wide Web, information access might also play a growing role in medical care, ³⁷ civic and political participation, lifelong learning, recreation and leisure activities, and personal finance. In short, information consumption, use of IT, and effective "knowledge management" could become increasingly instrumental to health, wealth, power, and overall quality of life.

The growing significance of information raises questions about the equity of access to information technologies. In addition, the steady growth of databases about individual citizens—and the power of IT to combine those data into

³⁵The higher effect sizes for studies published before 1970 are intriguing, and may reflect novelty impacts. Such effects result from the greater attention and effort an individual gives to a substantially new technology and not necessarily from any intrinsic contributions of the technology itself.

³⁶Ryan also had a precise set of stringent selection criteria, including the requirements that the study reflect experimental or quasi-experimental design, that the sample size be at least 40 students (a minimum of 20 students in the treatment and control groups), and that the treatment last eight weeks or longer.

³⁷Survey data indicate that people are increasingly using the World Wide Web for health-related information. See chapter 7, "The Use of Computer Technology in the United States."

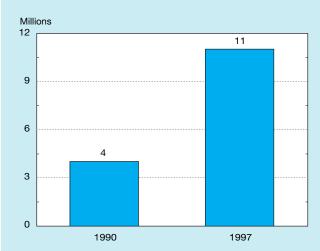
Trends in Telecommuting

Telecommuting is considered to be one of the more positive benefits of IT and networks. Working from home alleviates traffic congestion, accommodates family schedules, and enhances white-collar productivity. Telecommuting is promoted by such corporate giants as Motorola, AT&T, Sun Microsystems, IBM, Ernst and Young, and Hewlett Packard. Corporate telecommuters work almost half of their work week at home (about 19 hours).

The number of individuals who reported working as telecommuters in 1997 was 11 million, just under 10 percent of the U.S. labor force. (See figure 8-18.) The total is growing rapidly, however, at about 15 percent a year. Some analysts estimate that at least 40 percent of today's workers could be telecommuters at least part of the time. For these statistics and others, see Telecommute America (1997).

Figure 8-18.

Number of telecommuters in the United States



SOURCE: Telecommute America, "News Release July 2, 1997" << http://www.att.com/press/0767/970702.bsa.html#facts>>.

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highly revealing portraits about an individual—presents the possibility that rather than enhance personal liberty and wellbeing, information will instead tyrannize the private citizen. Although scholars have as yet found little evidence that the Internet changes the dynamics of democratic governance and discourse (see King and Kraemer 1997), the volume of data collected on private individuals without their consent has increased. This section therefore examines the impacts of IT on two dimensions of civil life: equity of opportunity and personal privacy. Note, however, that these are only two of the many ways in which IT may affect individuals. Other issues of interest include the role of information for per-

sonal empowerment and quality of life, the impact of IT on government services and public access to government services, and the potential impact of IT on human cognition and thinking processes.

Equity Issues

Equality of opportunity is a hallmark of U.S. political culture and reflects a national commitment to minimize structural barriers to personal achievement.³⁸ With respect to education and IT, equity is of particular concern not only because of the importance of training an adequately prepared workforce, but also because (as reviewed earlier) use of IT can affect children's learning ability. Personal and household access to computers and the Internet facilitates distance education, access to health information and government services, and job searches in classified ads. Inequality of information access and IT literacy could aggravate existing race, ethnic, and class divisions in the United States; conversely, equality of information access and information skills could help integrate ethnic groups, the poor, and rural communities into the economic and political systems.

Educational Inequities

Diffusion data indicate that pronounced educational inequalities in access to IT exist—key (and interrelated) determinants of access are income, race, and ethnicity. Schools with white, affluent, and suburban students have the greatest levels of IT adoption; schools with poor and minority students have considerably lower IT adoption rates. Inequities in access to IT may be particularly difficult to overcome when considered in the context of major inequalities in school facilities, resources, teacher training, and curriculum among ethnic minorities and the poor (Kozol 1991).

Differences exist in student computer use by race or ethnic group and grade level. (See figure 8-19.) At the elementary school level (grades 1-8), inequalities are particularly pronounced. While nearly three-quarters of all white elementary school children used computers at school in 1993, fewer than two-thirds of black and Hispanic children did. Because elementary school use of computers is particularly focused on drilland-practice activities in mathematics and reading, the data suggest that minority children are getting less computer-reinforced training in basic skills than their white counterparts. Although inequalities in computer use diminish by high school—about 55 percent of black and Hispanic teenagers use computers at school, compared to 60 percent of white teensvariations in the content of that use are notable. For example, college-bound minority students get less experience in all major areas of computing applications than college-bound whites except data processing and computer programming.

³⁸Structural barriers may reflect deliberate discrimination (such as hiring and promotion practices) as well as nondiscriminatory but excessively inequitable treatment (such as variations in school funding within a school district). In some instances, equal opportunity may also involve proactive efforts to correct inequalities among disadvantaged groups.

Figure 8-19. Student use of computers at school, by grade level and race/ethnicity: 1993 White ■ Black Grades Hispanic Other Grades 9-12 0 20 40 100 60 80 Percent of students Science & Engineering Indicators - 1998 See appendix table 8-8.

(See figure 8-20.) Female students get less experience than males in all applications except word processing and use in English courses.

These inequities in computer use at the elementary and high school levels could be the result of curriculum and teacher training as well as in-school access. As discussed earlier, research shows that use of computing resources depends on a teacher's training and ability to integrate computer-based instruction into the existing curriculum. One government report finds some evidence of differences in computer training among teachers of different ethnicity and socioeconomic status (PCAST 1997); however, diffusion data suggest that differences in students' school use of IT depend upon the availability of the equipment itself. Citing data from Quality Education Data, Inc., the Educational Testing Service (1997) notes that schools with a minority population of less than 25 percent have student-to-computer ratios of about 10 to 1, while schools with 90 percent or more minority students have ratios of 17.4 to 1. Similarly, the National Center for Education Statistics (1997) reports that schools with 50 percent or more minority students have Internet access in only 5 percent of their instructional classrooms, compared to 18 percent in schools with minority populations of 20 percent or less.

As with race and ethnicity, income is associated with student computer use. In 1993, three-quarters of all elementary school children from households with incomes greater than \$50,000 used a computer at school, compared to two-thirds (or below) for children from households with incomes lower than \$20,000. (See figure 8-21.) Internet access is similarly inequitable. Schools that have the largest proportion of economically disadvantaged students have less than one-half the level of Internet access as more affluent schools. (See figure 8-22 and

figure 1-17 in chapter 1.) In short, schools with large minority and poor populations have less access to all information technologies, including multimedia computers, cable TV, Internet hook-ups, interactive videodisk, CD-ROMs, and satellite connections (ETS 1997).

Household Inequities

Inequality of access to information technologies applies to adults as well as children. In 1993, about a third more whites used computers at work than blacks, and over a half more whites used computers at work than Hispanics. (See figure 8-23.) The disparity is even more pronounced regarding home use. The percentage of whites with a computer at home is twice that of blacks or Hispanics.³⁹

There appears to be a distinct class of "IT-disadvantaged" citizens. Adults who have not graduated from high school have one-fourth the level of ownership of home computers compared to those individuals with graduate or professional degrees. (See figure 8-24.) And the lowest income groups report one-ninth the level of computer ownership compared to individuals in the highest income brackets. (See figure 8-25.) Children share in this household inequity; more than 10 times as many of the most well-off children use computers at home as do the poorest students—more than 60 percent compared to about 5 percent. (See appendix table 8-8.)

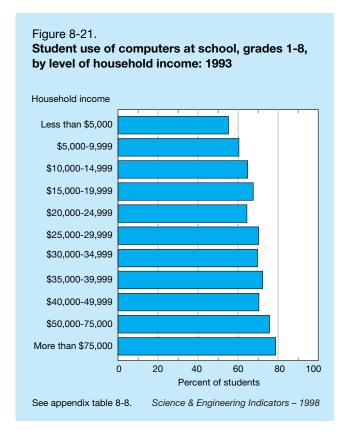
Geographic data shed light on the informationally disadvantaged. The National Telecommunications and Information Administration (NTIA) finds that "in essence, information 'have nots' are disproportionately found in this country's rural areas *and* its central cities, [however] no situation compares with the plight of the rural poor" (NTIA 1995). Only 5 percent of rural households with annual incomes of less than \$10,000 have computers—the lowest rate of ownership for any group. (See figure 8-26.) Unfortunately, these households cannot compensate for their lack of information access at home by using public libraries. As noted earlier, fewer than one-third of the libraries that serve communities of less than 5,000 have Internet access, compared to 93 percent of the libraries in metropolitan areas of 100,000 or more.

The irony of limited access by the poor, the least educated, and rural communities to information technologies is that when these groups gain access to IT and networks, they use the technology for self-advancement. NTIA reports that:

Many of the groups that are the most disadvantaged in terms of absolute computer and modem penetration are the most enthusiastic users of on-line services that facilitate economic uplift and empowerment. [Census survey data reveal that] low-income, minority, young, and less-educated computer house-holds in rural areas and central cities appear to be likely to engage actively in searching classified ads for employment, taking educational classes, and accessing government reports, on-line via modem (1995, p. 3).

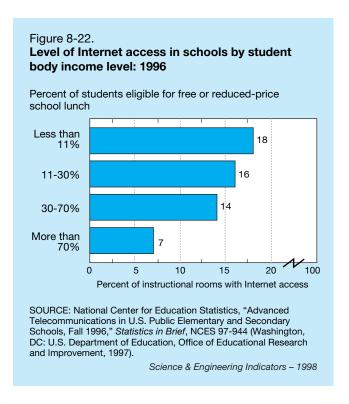
³⁹Note that white, black, and Hispanic computer owners *do* tend to have comparable technological access to networks: there are no meaningful differences among racial and ethnic groups in terms of whether their computers have modems. See NTIA (1995).

Figure 8-20. Computer-related experience of college-bound seniors, by sex, race/ethnicity, and computing applications: 1996 Asian American Male White Male Other race/ethnicity Black 52 25 Hispanic/Latino All 25 Mexican American Native American Other race/ethnicity 25 Female 48 Mexican American 48 All Puerto Rican Asian American 47 124 Computer Computer White Hispanic/Latino 123 programming literacy Native American Black 122 Puerto Rican Female 20 60 100 50 10 20 30 40 100 0 10 20 30 Percent of students Percent of students Asian American Male White Black 129 28 Native American 128 ΑII Mexican American Native American 128 Hispanic/Latino Asian American Other race/ethnicity Male 27 Other race/ethnicity Black 27 126 Female All 26 Data 25 Math Mexican American Female 25 problems processing Puerto Rican Puerto Rican White Hispanic/Latino 125 123 28 100 12 16 22 24 28 Percent of students Percent of students Male Native American Asian American 13 Asian American Other race/ethnicity 13 Male White 13 Other race/ethnicity ΑII 12 All White Native American 12 Black Female 10 Hispanic/Latino Female Social science Natural science Black Hispanic/Latino problems problems Mexican American Mexican American Puerto Rican Puerto Rican 100 10 12 14 100 6 8 Percent of students Percent of students White Female 75 Female 145 White 74 ΑII 73 Asian American Asian American 44 72 All Native American Other race/ethnicity 70 Other race/ethnicity 43 Native American 69 Male 142 Male 69 Mexican American 68 Mexican American Hispanic/Latino 133 67 Word Use in English Hispanic/Latino Black 32 course Puerto Rican processing Puerto Rican 30 Black 163 50 100 10 20 40 n 30 100 20 40 60 80 Percent of students Percent of students NOTE: Data are for college-bound seniors who took the SAT. SOURCE: Educational Testing Service, Computers and Classrooms: The Status of Technology in US Schools, Policy Information Report (Princeton: Educational Testing Service, Policy Information Center, 1997); data from The College Board. Science & Engineering Indicators – 1998



Bier et al. (1996) found similar results in a well-structured ethnographic study of home Internet use by six low-income families in Florida. These families were provided with home computers and Internet access to "see what families designated as 'informationally disadvantaged' would actually do on-line given unrestricted home Internet access" (p. 1). Families in the study used their computers and the Internet to acquire health information, create network support groups, search for jobs, and do school work. ⁴⁰ Individuals reported growth in their self-esteem, better grades, more effective communications with physicians, and closer relationships with their children. They also spoke of their fear of losing the technology because of the temporary nature of the study. As the authors summarize:

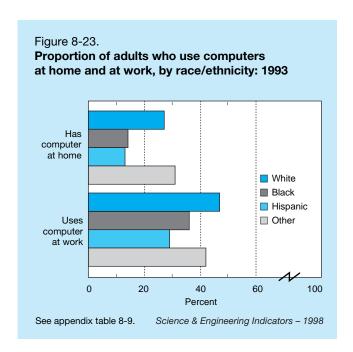
We did not anticipate the profound ways in which our participants' interactions with the technology and the relationships it made possible would change them, their sense of identity, and the content of their lives. While these changes were perceived as positive by the participants, our dilemma arose when participants began to express their growing fear of the time when they would be expected to return the borrowed equipment...According to use of human subjects research codes we met our ethical responsibility to the participants by clearly delineating the temporary nature of the resources provided...However, we have come to feel that adherence to these standard ethical requirements is insufficient to adequately address



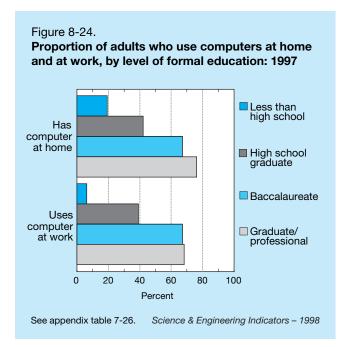
the principle of reciprocity in our relationships...In this study it became important...to actively support the positive potential awakened in the participants (p. 9).

Privacy Issues

IT offers extraordinary potential for collecting and reporting detailed information about individuals that many would consider to be private. Information on medical histories, credit records, shopping habits, spending practices, income levels, magazine subscriptions, video rentals, vacation preferences, and



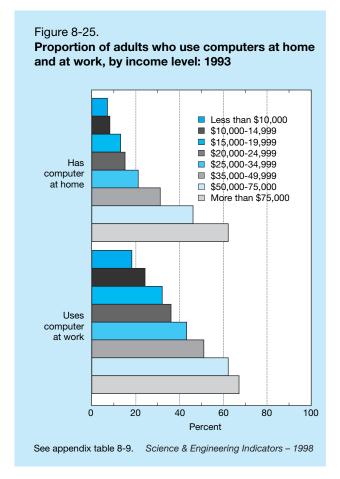
⁴⁰The authors state that "participants made use of virtual hospitals, medical dictionaries, and physician desk references. They joined support groups, visited international zoos, investigated scholarships, and made local transportation arrangements. They investigated appliances, looked at employment listings, and kept up with the local calendar of events" (Bier et al. 1996, p. 3).



even coupon usage is routinely collected by commercial enterprises and stored in databases. These databases are, in turn, sold, bought, and "overlayed" into detailed electronic files on millions of individuals. With no more information than a name, address, phone number, or birthdate, a persistent "data miner" can compile a dossier with detail and scope that would shock most individuals. The proliferation and commercialization of personal data and information—and the fact that it is happening without the consent of the individual has been well-documented (Smith 1994, Kahin and Nesson 1997, Regan 1995, Cavoukian and Tapscott 1997, and Culnan 1991). Other IT-related privacy issues include (but are not limited to) surveillance in the workplace (e.g., reading employees' e-mail and listening to their telephone calls) and tracking a person's Internet activities through an electronic tracer known as a "cookie."

Not surprisingly, Americans' concerns about protecting the privacy of their personal information and communications have been rising steadily for the past two decades. Concerns are sufficiently intense that more than a dozen pieces of related legislation have been passed since the 1970s (see Regan 1995 for a review). In addition, in 1994, Wisconsin became the first state in the country to establish an Office of the Privacy Advocate for its citizens, a bureau that actively promotes the protection of "personally identifiable" information.

Empirical measures of the proliferation of private information are not available. In addition, it is difficult to establish objective measures of violations of privacy, since privacy represents both values and psychological states. (In other words, violations of privacy are largely in the eye of the beholder.) If legal criteria are used—such as those of the 1974 Privacy Act, which essentially states that data cannot be collected on individuals without their permission—then we would be forced to conclude that violations of privacy are in fact commonplace.



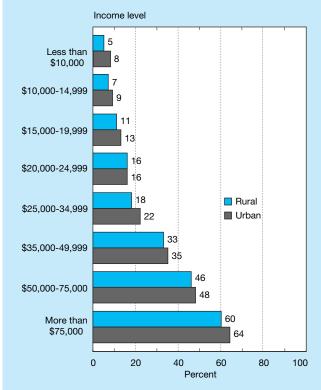
Easier to measure is a society's collective sense about privacy and its safeguards. A variety of public opinion polls regarding privacy have been administered over the past 15 years, and they document a public concern over privacy that is growing in scope and intensity. By the mid-1990s, more people registered stronger concerns about protecting their privacy than at any other time. For example, the 1996 Equifax/Harris Consumer Privacy Survey found that 65 percent of those polled reported that protecting the privacy of consumer information was very important to them—an increase of 4 percentage points over the previous year (Equifax 1997).⁴¹ Medical privacy appears to be of particular concern (NRC 1997). In 1993, 96 percent of those surveyed believed that "federal legislation should designate all personal medical information as 'sensitive' and impose penalties for unauthorized disclosure."42 Confidence in controls on information marketing is not strong, however. In 1993, nearly half of all respondents to the Equifax/Harris survey indicated that they agreed strongly with the statement that "consumers have lost all control over how personal information about them is

⁴¹The wording of the Equifax/Harris polls has changed over time, making direct comparisons across multiple years difficult. Analysts do, however, conclude that the trend in public opinion is distinctly toward greater and more intense concerns over violations of privacy (Regan 1995, and Cavoukian and Tapscott 1997).

⁴²Based on the 1993 Equifax/Harris Health Information Privacy Survey. See EPIC (1997).

Figure 8-26.

Percentage of U.S. households with a computer, by income level and geographic location: 1994



NOTE: "Rural" reflects populations of less than 2,500 persons; "urban" reflects populations of more than 2,500 persons.

SOURCE: National Telecommunications and Information Administration, Falling Through the Net: A Survey of the "Have Nots" in Rural and Urban America, <<http://www.ntia.doc.gov/ntiahome/fallingthru.html>> (August 1997); table can be accessed at <<ht>http://www.ntia.doc.gov/ntiahome/tables.html>>. Data are based on the U.S. Bureau of the Census, Current Population Survey, November 1994.

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circulated and used by companies," a response 27 percent higher than that reported just two years previously (Regan 1995). In addition, 60 percent of those surveyed in an American Civil Liberties Union poll believe that their health insurance data are being accessed by others for secondary uses (EPIC 1997).

Americans strongly believe in their right to information privacy. Ninety-three percent of respondents in a 1991 Time-CNN poll believed that "companies that sell information to others should be required by law to ask permission from individuals before making the information available." The vast majority of people believe that companies should be prohibited from selling information about household income (90 percent), bill-paying history (86 percent), and product purchases (68 percent) (EPIC 1996). With respect to Internet use, the 1996 Georgia Tech Fifth World Wide Web Poll revealed that on-line Web users almost unanimously valued the ability to visit Web sites anonymously (rating this item as 4.6 on a scale of 5), and strongly opposed the right of site providers to sell information about their users to other companies (rating the right to sell at 1.7 on a scale of 5) (EPIC 1996).

Conclusion

The Need for IT Metrics

Metrics are a form of information and are ideally developed to answer specific sorts of questions. Which measures a society collects and analyzes about the effects of a technology depends largely upon what it wants to know, and we would not expect that all societies necessarily want to know the same things. The metrics and analyses presented here are based on four central questions:

- ♦ How extensively is IT embedded in American society?
- ♦ How is IT being used for business, educational, and other needs?
- ♦ What are the positive consequences of this use?
- What are the warning signals about the negative consequences of this use?

Available metrics exhibit considerable weaknesses in their ability to answer the above questions. The single most important obstacle to effective data collection is the lack of standardized definitions of IT, and the exclusion of important costs associated with IT use. For example, in some economic studies, IT reflects only computers, while in others it captures computers and telecommunications hardware. Research shows that IT support personnel and training expenses are significant elements of the cost and effective use of IT, but that these expenses are not always included in research studies or data collection. To fully capture the extent of the technology, IT should be defined as computers and telecommunications equipment. In addition, IT-associated costs should be included when collecting expenditure data on IT. Key associated costs include software, personnel expenses for IT support staff (e.g., network administrators), and training expenses for individuals who use the technology. One major obstacle to more effective data collection is the lack of appropriate budgeting and accounting reporting systems at the organizational level. Another is that IT itself continues to change rapidly.

A further weakness is the relative absence of systematic information on how IT is actually being used. IT is a means to an end—principally information processing. A real appreciation for the impacts and consequences of IT requires understanding what information it allows us to collect, access, and process. The presence of the hardware itself does not tell us to what ends it is put, and it is the actual use of the technology that determines its effects. Systematic surveys of IT applications are thus in order. For example, time-ontask audits would reveal how individuals actually use computers and networks at their office, school, or home; analytical questions about the impacts of specific IT activities would develop from patterns of real use. Similarly, diffusion estimates for specific types of applications (such as CAD-CAM, electronic data interchange, inventory management systems, and business management systems) could narrow down and help identify impact-related questions. Systematic knowledge

Metric	Source of data	Comments
IT investments in industry (diffusion indicator)	U.S. Bureau of Economic Analysis	Investments in IT disaggregated by type of technology. Reported as an annual investment as well as capital stock at the individual industry level.
IT hardware in K-12 schools (diffusion indicator)	Quality Education Data Inc., Denver, CO	Investments in several types of IT (computers, satellites, CD-ROMs, etc.) by school and location. Contains detailed data about school demographics.
K-12 Internet access (diffusion indicator)	National Center for Education Statistics	Extent of Internet access by type of school and location; contains detailed data about school demographics.
Library Internet access	American Library Association	Extent of Internet access by libraries (public and academic). Detailed data on size of community library services.
Individual perceptions of privacy (impact indicator)	Equifax/Harris Survey	Time-series data on public perceptions about violations of information privacy and rights to information privacy.
Patterns of individual use of the World Wide Web (usage indicator)	Georgia Tech Internet Survey	How individuals use the Internet and values about access to information.

about the degree of importance of different uses and applications of IT is missing.

Recommendations for IT Metrics

Diffusion indicators for IT are relatively abundant and analytically useful. Several good data series exist that could be compiled into an ongoing set of diffusion metrics. These indicators are presented in text table 8-7, and include IT investments and stocks by industry and IT in K-12 schools. A lack of diffusion/IT intensity metrics is notable for both the education and economic sectors with respect to IT-associated costs—personnel, software, and training. These IT expenses are emerging in the research as significant determinants of IT effectiveness, and need to be tracked on a systematic basis. The most striking lack of data relates to distance education: by definition, this is learning that takes place through the use of information technologies, and there are simply no reliable metrics on the scope and growth of this unique educational practice.

Impact measures for the economy are problematic, primarily because of the difficulty in measuring economic output for many of the service sectors. One alternative to this dilemma is to select a representative set of sectors—or those that are the most economically significant—and develop a set of impact metrics unique to each. The research evidence

suggests that IT impacts are highly firm- and industry-specific; it is unlikely that a single measure could capture the economic benefits of IT for all types of enterprises. Three potential measures—as illustrated by the banking industry—are those that reflect the volume of transactions processing, human versus electronic transaction costs for key types of transactions, and processing times for key transactions.

Impact assessments for IT and learning are complicated by a more severe measurement issue, which is the need to collect data through observational studies or controlled experiments. Meta-analysis suggests that computer-based instruction generates real learning impacts, but more rigorous and comprehensive studies need to be conducted. A largescale controlled study would be one way to avoid the statistical dilemmas of small classroom experiments.

Finally, IT clearly raises quality-of-life issues for the individual citizen. Occupational injury, psychological stress, and violations of privacy are clearly potential dangers of the widespread use of information technologies in the workplace and in information-intensive industries. Consistent tracking of the hazards to the individual represented by extensive use of IT is in order. Because IT also can clearly enhance quality of life, inequity in IT access could create more social stratification in the United States. Ongoing monitoring of equity indicators is critical as the significance of IT to employment, health, and well-being grows.

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Appendix table 1-1. **Proportion of high school graduates earning credits in science courses, by sex: 1982, 1987, 1990, and 1994** (Percentages)

Year of graduation and sex	Any science	Survey science	Biology	AP/honors biology	Chemistry	AP chemistry	Physics	AP/honors physics
1982 graduates								
All	96.5 (0.3)	62.1 (1.2)	76.6 (0.8)	9.7 (0.5)	31.1 (0.8)	3.0 (0.4)	14.4 (0.5)	1.1 (0.1)
Male	96.3 (0.3)	63.6 (1.4)	74.5 (0.9)	9.0 (0.5)	32.2 (1.2)	3.5 (0.5)	19.1 (1.0)	1.5 (0.2)
Female	96.7 (0.3)	60.8 (1.3)	78.6 (1.1)	10.3 (0.8)	30.2 (0.7)	2.4 (0.5)	10.2 (0.4)	0.7 (0.1)
1987 graduates								
All	99.1 (0.2)	61.3 (3.1)	87.9 (1.0)	9.5 (0.8)	43.8 (1.1)	3.3 (0.4)	19.3 (0.9)	1.7 (0.3)
Male	98.8 (0.2)	61.8 (3.0)	86.3 (1.2)	9.4 (0.8)	44.3 (1.3)	3.9 (0.5)	24.1 (1.0)	2.5 (0.4)
Female	99.3 (0.1)	60.7 (3.3)	89.5 (0.8)	9.6 (1.0)	43.2 (1.2)	2.7 (0.3)	14.7 (0.9)	0.9 (0.2)
1990 graduates								
All	99.4 (0.1)	68.1 (1.8)	91.1 (1.0)	10.1 (1.0)	48.9 (1.3)	3.5 (0.5)	21.6 (0.8)	2.0 (0.4)
Male	99.1 (0.3)	69.6 (1.9)	89.6 (1.1)	9.3 (1.0)	47.7 (1.4)	4.1 (0.5)	25.4 (0.9)	2.5 (0.5)
Female	99.7 (0.1)	66.7 (1.9)	92.4 (0.9)	10.8 (1.2)	50.0 (1.3)	2.9 (0.5)	18.0 (0.9)	1.6 (0.3)
1994 graduates								
All	99.6 (0.1)	71.2 (2.0)	93.4 (1.0)	11.8 (0.9)	55.7 (1.1)	4.0 (0.5)	24.6 (0.8)	2.7 (0.3)
Male	99.5 (0.2)	72.6 (2.0)	92.0 (1.1)	10.9 (0.9)	52.8 (1.1)	4.1 (0.6)	27.1 (1.0)	3.4 (0.4)
Female	99.8 (0.1)	69.9 (2.1)	94.7 (0.9)	12.7 (1.1)	58.5 (1.2)	3.7 (0.5)	22.2 (0.9)	2.0 (0.3)

AP = advanced placement

NOTE: Standard errors are shown in parentheses.

SOURCE: National Center for Education Statistics, *The 1994 High School Transcript Study Tabulations: Comparative Data on Credits Earned and Demographics for 1994, 1990, 1987, and 1982 High School Graduates, NCES 97-260 (Washington, DC: U.S. Department of Education, 1997).*

See figure 1-1.

Appendix table 1-2. Proportion of high school graduates earning credits in science courses, by race/ethnicity: 1982, 1987, 1990, and 1994 (Percentages)

Year of graduation and race/ethnicity	Any science	Survey science	Biology	AP/honors biology	Chemistry	AP chemistry	Physics	AP/honors physics
1982 graduates								
White	96.9 (0.3)	61.6 (1.4)	78.6 (1.0)	10.9 (0.7)	34.4 (0.9)	3.3 (0.5)	16.5 (0.6)	1.2 (0.2)
Asian/Pacific Islander	95.9 (1.3)	40.9 (5.1)	83.7 (2.2)	17.5 (2.9)	52.8 (4.4)	5.8 (1.3)	34.8 (3.4)	3.4 (1.0)
Black	97.1 (0.5)	67.8 (1.8)	73.0 (1.9)	6.0 (1.3)	22.3 (1.5)	1.6 (0.6)	7.6 (0.8)	0.9 (0.4)
Hispanic	93.5 (1.1)	63.3 (1.6)	68.6 (2.1)	4.8 (0.7)	15.6 (1.0)	1.4 (0.4)	5.6 (0.6)	0.4 (0.1)
Native American	91.6 (4.9)	58.1 (7.7)	67.4 (7.0)	3.2 (1.8)	26.2 (7.0)	0.9 (0.9)	8.2 (3.1)	0.0 (0.0)
1987 graduates								
White	99.2 (0.2)	60.7 (3.6)	88.8 (1.1)	9.6 (0.9)	46.7 (1.2)	3.4 (0.4)	20.6 (1.0)	1.7 (0.3)
Asian/Pacific Islander	99.6 (0.3)	44.8 (5.2)	92.1 (1.3)	23.6 (4.4)	70.2 (3.7)	15.4 (2.5)	46.9 (4.2)	6.2 (1.4)
Black	99.0 (0.3)	71.8 (3.8)	84.6 (1.8)	5.2 (0.7)	28.4 (1.8)	1.1 (0.3)	9.7 (1.1)	0.4 (0.1)
Hispanic	99.1 (0.3)	66.9 (3.2)	85.5 (1.5)	7.6 (1.1)	29.1 (1.5)	2.2 (0.6)	9.9 (1.1)	0.8 (0.3)
Native American	99.1 (0.7)	67.3 (3.3)	90.9 (1.9)	13.0 (3.6)	26.4 (2.0)	0.6 (0.3)	8.4 (2.4)	1.4 (0.5)
1990 graduates								
White	99.4 (0.2)	67.6 (2.0)	91.3 (1.1)	10.5 (1.0)	51.4 (1.4)	3.7 (0.6)	23.1 (0.9)	2.1 (0.4)
Asian/Pacific Islander	99.6 (0.2)	56.7 (7.1)	90.4 (2.7)	13.4 (4.0)	63.6 (4.0)	7.7 (1.9)	38.4 (3.5)	5.9 (2.6)
Black	99.5 (0.2)	75.3 (3.1)	91.1 (2.2)	7.7 (1.9)	40.0 (2.2)	2.5 (0.9)	14.5 (1.9)	0.7 (0.3)
Hispanic	99.1 (0.3)	72.0 (3.5)	90.1 (1.4)	6.7 (1.3)	38.1 (2.9)	1.1 (0.4)	13.2 (1.3)	1.0 (0.4)
Native American	98.7 (1.2)	69.4 (5.8)	89.4 (4.7)	3.8 (2.0)	34.9 (4.6)	4.4 (2.6)	14.5 (3.8)	0.5 (0.5)
1994 graduates								
White	99.8 (0.1)	72.4 (2.3)	94.2 (1.2)	12.4 (1.1)	58.2 (1.1)	4.3 (0.6)	26.1 (1.0)	2.7 (0.4)
Asian/Pacific Islander	99.4 (0.4)	62.0 (4.5)	91.5 (1.4)	18.2 (3.1)	69.2 (4.8)	7.7 (1.5)	44.4 (3.7)	6.7 (1.5)
Black	99.8 (0.1)	71.7 (3.7)	91.8 (2.1)	7.7 (1.0)	43.7 (2.7)	2.1 (0.7)	15.0 (1.2)	1.8 (0.4)
Hispanic	99.3 (0.2)	69.7 (3.1)	93.7 (0.6)	11.0 (1.1)	46.0 (2.8)	2.5 (0.6)	16.1 (1.4)	1.9 (0.5)
Native American	99.7 (0.3)	79.0 (5.1)	91.8 (2.1)	6.2 (2.9)	41.3 (5.4)	0.6 (0.6)	10.3 (2.8)	0.3 (0.3)

AP = advanced placement

NOTE: Standard errors are shown in parentheses.

SOURCE: National Center for Education Statistics, *The 1994 High School Transcript Study Tabulations: Comparative Data on Credits Earned and Demographics for 1994, 1990, 1987, and 1982 High School Graduates, NCES 97-260 (Washington, DC: U.S. Department of Education, 1997).*

See figure 1-2.

Appendix table 1-3. Trends in a National Assessment of Educational Progress in science, by age, sex, and race/ethnicity: 1969-96, selected years

				Difference,			Difference,		Difference,
	All students	Males	Females	male vs. female	Whites	Blacks	white vs. black	Hispanics	white vs. Hispanic
Age 9									
1970								ΑN	NA
1973								A	N
1977								192 (2.7)	
1982								189 (4.2)	
1986								199 (3.1)	
1990								206 (2.2)	
1992								205 (2.8)	
1994	231 (1.2)	232 (1.3)	230 (1.4)	2 (1.9)	240 (1.3)	201 (1.7)	39 (2.2)	201 (2.7)	39 (3.0)
1996	230 (1.2)	232 (1.8)						207 (2.5)	
Age 13									
1970								AN	NA
1973								ΑN	Ν
1977								213 (1.9)	43 (2.1)
1982	250 (1.3)	256 (1.5)	245 (1.3)	11 (2.0)	257 (1.1)	217 (1.3)	40 (1.7)	226 (3.9)	32 (4.0)
1986								226 (3.1)	33 (3.4)
1990								232 (2.6)	
1992								238 (2.6)	
1994								232 (2.4)	
1996	256 (1.0)	261 (1.1)						232 (2.5)	
Age 17									
1969								AA	N
1973								N A	A
1977								262 (2.2)	
1982								249 (2.3)	44 (2.5)
1986								259 (3.8)	
1990	290 (1.1)	296 (1.3)	285 (1.6)	10 (2.1)	301 (1.1)	253 (4.5)	48 (4.6)	262 (4.4)	40 (4.5)
1992								270 (5.6)	
1994								261 (6.7)	45 (6.9)
1996							47 (2.6)	269 (3.0)	38* (3.2)

* = average scale score difference in 1996 is significantly lower than in first year listed; NA = not available

Science & Engineering Indicators – 1998 SOURCE: J. Campbell, C. Reese, C. O'Sullivan, and J. Dossey, NAEP 1994: Trends in Academic Progress (Washington, DC: National Center for Education Statistics, 1996).

See figure 1-3.

NOTES: Scale scores range from 0 to 300 for every grade level. Standard errors are shown in parentheses.

Science & Engineering Indicators – 1998

Appendix table 1-4. Grade 8 average scale scores on the National Assessment of Educational Progress in science, by state and race/ethnicity: 1996

		All students	dents	Wh	White		Asian/Pa	Asian/Pacific Islander		Black		Hispanic	o	Native American	merican	
State	Average scale score		Percentage of students	Average scale score	Percentage of students		Average scale score	Percentage of students	Average score	Percentage re of students	Average score		Percentage of students	Average scale score	Percentage of students	tage
Nation		(6.0)	100.0	159 (1.1)	89	(0.4)	50 (3.3)	2 (0.3)	120 (1.2)) 15 (0.3)	127 (1	(1.8)	12 (0.3)	148 (4.2)	: ۲۵	(0.3)
Alabama	_	(1.6)	100.0				YA Y			33					≦ :	:
Alaska		(1.3)	100.0			•	52 (3.8)	7 (1.0)		4				129 (3.4)	16	(1.4)
Arizona	145 (1	(1.6)	100.0				¥	ΑΝ		4					9	(1.5)
Arkansas	144 (1	(1.3)	100.0	154 (1.5)					116 (2.5)	50				NA	₹	
California	138 (1	(1.7)	100.0	156 (1.7)		•	$\overline{}$			7				NA	Ϋ́	
Colorado	155 (0	(6.0)	100.0	162 (0.8)		•				2				142 (4.3)	က	(0.4)
Connecticut	155 (1	(1.3)	100.0	165 (1.0)		•	163 (3.7)	3 (0.4)		10	122 (2		11 (0.9)		Ϋ́	
	142 (0	(0.8)	100.0	152 (0.8)						56				Ą	₹	
Florida		(1.6)	100.0				¥	Ϋ́		20				ž	¥	
Georgia	_	(4.1)	100.0				AN	Ϋ́Z	122 (1.4)	36	128 (4	(4.2)	5 (0.4)	ΑN	Ϋ́	
Hawaii		(0.7)	100.0			•	38 (1.1)	54 (1.3)		က				Ϋ́	Ϋ́	
Indiana		(4.1)	100.0	158 (1.3)						Ξ		(2.1)		ΑN	Ą	
lowa	158 (1	(1.2)	100.0				AN	Ϋ́Z		က				ΑN	Ϋ́	
Kentucky		(1.2)	100.0				¥	Ϋ́Z		0				ΑN	Ϋ́	
Louisiana		(1.6)	100.0				¥	Ϋ́Z	113 (2.1)	37				Ą	Ž	
Maine		(1.0)	100.0				Y Z	Ψ.Z		-		(4.6)		Υ N	Ϋ́	
Maryland		(E	1000							32				ΔN	ΔN	
Massachusetts		() (A	100.0				52 (7.3)	4 4 (0.0)		9 6		(o e		ΔN	Ž Z	
Michigan		F =	100.0							, L				2 2	2 2	
Misseets			0000			•	14 C	<u> </u>	122 (2.4)	<u>0</u> -		(v. f)		ζ <u><</u>	<u> </u>	
Willinesota		ઈ .	0.001					(6.0)		7 ;				Z :	<u> </u>	
Mississippi	_	(4. E. 2)	100.0				₹ :	¥ ;		4 4				Y :	₹ :	
Missouri		(7.7)	0.001				≰ :	¥ :	120 (2.8)	<u>ي</u>					≦ !	ĵ
Montana		(1.2)	100.0				₹	A A		-				139 (2.7)	9	(1.7)
Nebraska		(1.0)	100.0				¥	ΑΝ	130 (3.1)	2	134 (3				Ϋ́	
New Mexico		(1.0)	100.0							က				126 (2.4)	∞	(0.0)
New York	146 (1	(1.6)	100.0				155 (5.4)	(0.0)	120 (1.9)	17					Ϋ́	
North Carolina	147 (1	(1.2)	100.0				¥	ΑN		27					က	(1.4)
North Dakota	162 (0	(0.8)	100.0	164 (0.8)				ΑN	*		137 (4	(4.5)		137 (6.9)	က	(0.7)
Oregon	155 (1	(1.6)	100.0			•				7					4	(0.8)
Rhode Island	149 (0	(0.8)	100.0	155 (0.9)		•	142 (3.1)	4 (0.4)	130 (2.8)	2				NA	Ϋ́	
South Carolina	139 (1	(1.5)	100.0	153 (1.6)						40	122 (4			NA	Ϋ́	
Tennessee	143 (1	(1.8)	100.0	151 (1.7)			NA	ΑN		17				NA	Ϋ́	
Texas	145 (1	(1.8)	100.0	161 (1.2)		•	(3.6)		127 (2.4	12				NA	Ϋ́	
Utah	156 (0	(0.8)	100.0	159 (0.7)		•	143 (3.2)	3 (0.4)	*	-				NA	₹	
Vermont	157 (1	(1.0)	100.0	159 (0.9)					*	_	_			NA	Ϋ́	
Virginia	149 (1	(1.6)	100.0	158 (1.4)		•	165 (3.2)	5 (0.6)		24 (1.9)			5 (0.6)	NA	Ϋ́	
Washington	150 (1	(1.3)	100.0	156 (1.1)		•	149 (3.3)			4		(3.5)		130 (4.3)	4	(9.0)
West Virginia	147 (0	(0.9)	100.0	149 (0.9)					127 (3.2)	4	122 (4			NA	Ϋ́	
Wisconsin	160 (1	(1.7)	100.0	165 (1.1)			NA	ΑN		9	_	(4.6)		NA	Ϋ́	
Wyoming	158 (0	(0.0)	100.0	161 (0.6)		(0.8)	₹	Ν V	*	1 (0.2)	140 (1	(1.9)	(0.6)	138 (2.5)	4	(0.4)
																1

^{* =} sample size insufficient to permit reliable estimates; NA = not available

NOTES: Scale scores range from 0 to 300. Idaho, Illinois, Kansas, Nevada, New Hampshire, New Jersey, Ohio, Oklahoma, Pennsylvania, and South Dakota did not participate in the assessment. Standard errors are shown in parentheses. National results are based on the national assessment samples, not on aggregated state assessment program samples.

SOURCE: C. O'Sullivan, C. Reese, and J. Mazzeo, NAEP 1996 Science Report Card for the Nation and the States (Washington, DC: National Center for Education Statistics, 1997).

See figure 1-4.

Appendix table 1-5.

Overall mean and average percentage correct on grade 4 TIMSS science assessment, by country and content area: 1994-95

Country	Mean	All science content areas	Earth science	Life science	Physical science	Environmental issues/nature of science
All countries	524	59 0.1	57 0.1	64 0.1	57 0.2	51 (0.2)
Australia	562 (2.9)	66 (0.5)	61 (0.6)	72 (0.5)	63 (0.7)	63 (0.8)
Austria	565 (3.3)	66 (0.7)	62 (0.8)	72 (0.7)	64 (0.8)	54 (1.0)
Canada	549 (3.0)	64 (0.6)	62 (0.6)	68 (0.6)	61 (0.7)	56 (0.7)
Cyprus	475 (3.3)	51 (0.5)	48 (0.7)	55 (0.5)	50 (0.7)	42 (1.0)
Czech Republic	557 (3.1)	65 (0.5)	64 (0.6)	71 (0.5)	62 (0.7)	56 (0.9)
England and Wales	551 (3.3)	63 (0.6)	61 (0.6)	68 (0.6)	60 (0.8)	56 (1.0)
Greece	497 (4.1)	54 (0.8)	52 (0.9)	61 (0.9)	49 (0.9)	43 (1.2)
Hong Kong	533 (3.7)	62 (0.7)	61 (0.6)	68 (0.7)	60 (0.8)	50 (1.1)
Hungary	532 (3.4)	62 (0.6)	62 (0.7)	66 (0.6)	59 (0.8)	50 (0.9)
Iceland	505 (3.3)	55 (0.7)	55 (0.7)	60 (0.8)	52 (0.7)	47 (1.2)
Iran	416 (3.9)	40 (0.7)	38 (0.7)	44 (0.7)	40 (0.9)	26 (0.9)
Ireland	539 (3.3)	61 (0.6)	60 (0.8)	66 (0.6)	57 (0.7)	55 (0.9)
Israel	505 (3.6)	57 (0.8)	51 (0.8)	61 (0.9)	55 (0.9)	51 (1.3)
Japan	574 (1.8)	70 (0.3)	66 (0.4)	73 (0.3)	70 (0.4)	62 (0.6)
Kuwait	401 (3.1)	39 (0.5)	36 (0.6)	45 (0.6)	37 (0.5)	25 (0.7)
Latvia	512 (4.9)	56 (0.8)	57 (1.0)	60 (0.8)	54 (0.9)	46 (1.2)
Netherlands	557 (3.1)	67 (0.5)	61 (0.6)	73 (0.5)	65 (0.6)	61 (0.9)
New Zealand	531 (4.9)	60 (0.9)	57 (0.9)	66 (0.9)	57 (1.1)	54 (1.2)
Norway	530 (3.6)	60 (0.6)	60 (0.6)	67 (0.7)	55 (0.7)	53 (0.9)
Portugal	480 (4.0)	50 (0.7)	50 (0.8)	54 (0.8)	49 (0.9)	39 (1.0)
Scotland	536 (4.2)	60 (0.8)	58 (0.9)	65 (0.8)	57 (0.8)	53 (1.2)
Singapore	547 (5.0)	64 (0.8)	58 (0.8)	70 (0.8)	64 (0.8)	53 (1.1)
Slovenia	546 (3.3)	64 (0.7)	64 (0.7)	68 (0.7)	61 (0.8)	54 (0.8)
South Korea	597 (1.9)	74 (0.4)	72 (0.5)	76 (0.4)	75 (0.5)	70 (0.8)
Thailand	473 (4.9)	49 (0.9)	48 (0.9)	52 (0.8)	46 (1.0)	48 (1.4)
United States	565 (3.1)	66 (0.5)	64 (0.7)	71 (0.6)	60 (0.6)	65 (0.8)

TIMSS = Third International Mathematics and Science Study

NOTE: Standard errors are shown in parentheses.

SOURCE: M. Martin, I. Mullis, A. Beaton, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1997).

See figure 1-5.

Appendix table 1-6.

Overall mean and average percentage correct on grade 8 TIMSS science assessment, by country and content area: 1994-95

Country	Me	ean	sci co	All ence ntent reas		arth ence		₋ife ence	Ph	ysics	Che	mistry	menta nat	viron- I issues ure of ience
All countries	516		56	(0.1)	55	(0.1)	59	(0.1)	55	(0.1)	51	(0.2)	53	(0.2)
Australia	545	(3.9)	60	(0.7)	57	(0.8)	63	(0.8)	60	(0.7)	54	(0.9)	62	(1.0)
Austria	558	(3.7)	61	(0.7)	62	(0.8)	65	(0.7)	62	(0.7)	58	(1.1)	55	` '
Belgium (Flemish)	550	(4.2)	60	(1.1)	62	(1.2)	64	(1.1)	61	(1.1)	51	(1.3)	58	` '
Belgium (French)	471	(2.8)	50	(0.7)	50	(0.9)	55	(0.9)	51	(0.7)	41	(0.8)	46	` '
Bulgaria	565	(5.3)	62	(1.0)	58	(1.2)	64	(1.0)	60	(1.0)	65	(1.7)	59	` ,
Canada	531	(2.6)	59	(0.5)	58	(0.6)	62	(0.6)	59	(0.4)	52	(0.7)	61	(0.7)
Colombia	411	(4.1)	39	(0.8)	37	(8.0)	44	(0.9)	37	(0.8)	32	(1.0)	40	` ,
Cyprus	463	(1.9)	47	(0.4)	46	(0.6)	49	(0.5)	46	(0.4)	45	(0.6)	46	` ,
Czech Republic	574	(4.3)	64	(0.8)	63	(1.2)	69	(0.8)	64	(0.7)	60	(1.2)	59	` '
Denmark	478	(3.1)	51	(0.6)	49	(0.7)	56	(0.7)	53	(0.7)	41	(0.8)	47	` ,
England and Wales	552	(3.3)	61	(0.6)	59	(0.7)	64	(0.7)	62	(0.7)	55	(0.8)	65	
France	498	(2.5)	54	(0.6)	55	(0.8)	56	(0.8)	54	(0.5)	47	(0.9)	53	(0.9)
Germany	431	(4.8)	58	(1.0)	57	(1.0)	63	(1.1)	57	(1.0)	54	(1.3)	51	
•	497	` '	52	(0.5)	49	(0.6)	54	(0.6)	53	` '		` '	51	` '
Greece	522	(2.2)			54	` '	61	` '	58	(0.5))	51 55	(0.5)		(- /
Hong Kong		(4.7)	58	(1.0)		(1.0)		(1.0)		(0.9)	55	(1.0)	55	` ,
Hungary	554	(2.8)	61	(0.6)	60	(0.8)	65	(0.7)	60	(0.6)	60	(0.8)	53	` ,
Iceland	494	(4.0)	52	(0.9)	50	(1.2)	58	(1.0)	53	(0.9)	42	(0.8)	49	(1.0)
Iran	470	(2.4)	47	(0.6)	45	(0.6)	49	(0.6)	48	(0.7)	52	(8.0)	39	` '
Ireland	538	(4.5)	58	(0.9)	61	(1.0)	60	(1.1)	56	(8.0)	54	(1.0)	60	` '
Israel	524	(5.7)	57	(1.1)	55	(1.1)	61	(1.1)	57	(1.1)	53	(1.5)	52	` ,
Japan	571	(1.6)	65	(0.3)	61	(0.4)	71	(0.4)	67	(0.3)	61	(0.5)	60	` ,
Kuwait	430	(3.7)	43	(0.9)	43	(1.0)		(1.1)	43	(0.7)	40	(1.5)	39	` ,
Latvia	485	(2.7)	50	(0.6)	48	(8.0)	53	(0.7)	51	(0.7)	48	(8.0)	47	` '
Lithuania	476	(3.4)	49	(0.7)	46	(0.9)	52	(0.9)	51	(0.7)	48	(0.9)	40	` ,
Netherlands	560	(5.0)	62	(1.0)	61	(1.4)	67	(1.4)	63	(0.9)	52	(0.9)	65	` '
New Zealand	525	(4.4)	58	(8.0)	56	(0.9)	60	(1.0)	58	(0.7)	53	(1.1)	59	(1.2)
Norway	527	(1.9)	58	(0.4)	61	(0.6)	61	(0.5)	57	(0.4)	49	(0.6)	55	(8.0)
Portugal	480	(2.3)	50	(0.6)	50	(0.7)	53	(0.6)	48	(0.5)	50	(0.9)	45	(8.0)
Romania	486	(4.7)	50	(8.0)	49	(1.0)	55	(1.0)	49	(8.0)	46	(1.0)	42	(1.0)
Russian Federation	538	(4.0)	58	(8.0)	58	(8.0)	62	(0.7)	57	(0.9)	57	(1.3)	50	(8.0)
Scotland	517	(5.1)	55	(1.0)	52	(1.0)	57	(1.1)	57	(8.0)	51	(1.3)	57	(1.4)
Singapore	607	(5.5)	70	(1.0)	65	(1.1)	72	(1.0)	69	(8.0)	69	(1.2)	74	(1.1)
Slovak Republic	544	(3.2)	59	(0.6)	60	(0.7)	60	(0.6)	61	(0.6)	57	(8.0)	53	(0.9)
Slovenia	560	(2.5)	62	(0.5)	64	(0.7)	65	(0.6)	61	(0.6)	56	(0.9)	59	(0.9)
South Africa	326	(6.6)	27	(1.3)	26	(1.1)	27	(1.3)	27	(1.4)	26	(1.4)	26	(1.3)
South Korea	565	(1.9)	66	(0.3)	63	(0.5)	70	(0.4)	65	(0.5)	63	(0.6)	64	(0.8)
Spain	517	(1.7)	56	(0.4)	57	(0.5)	58	(0.5)	55	(0.4)	51	(0.7)	53	` '
Sweden	535	(3.0)	59	(0.6)	62	(0.7)	63	(0.7)	57	(0.5)	56	(0.7)	52	` '
Switzerland	522	(2.5)	56	(0.5)	58	(0.6)	59	(0.6)	58	(0.5)	50	(0.7)	51	(/
Thailand	525	(3.7)	57	(0.9)	56	(1.0)	66	(0.9)	54	(0.7)	43	(1.2)	62	()
United States	534	(4.7)	58	(1.0)	58	(1.0)		(1.1)	56	(0.8)		(1.2)	61	` ,

TIMSS = Third International Mathematics and Science Study

NOTE: Standard errors are shown in parentheses.

SOURCE: A. Beaton, M. Martin, I. Mullis, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1996).

See figure 1-6.

Appendix table 1-7. Average percentage correct on TIMSS science assessment, by country, grade, and sex: 1994-95

	Grad	e 4	Grad	e 8
Country	Boys	Girls	Boys	Girls
Australia	67 (0.6) ^a	65 (0.6)	61 (1.0)	59 (0.8)
Austria	67 (0.9) ^a	64 (0.7)	63 (0.8)	60 (0.8)
Belgium (Flemish)	NP	NP	62 (1.7)	59 (1.5)
Belgium (French)	NP	NP	52 (1.0)	49 (0.7)
Canada	64 (0.7)	63 (0.6)	60 (0.6)	58 (0.6)
Colombia	NP	NP	40 (1.4)	37 (0.8)
Cyprus	51 (0.7)	50 (0.6)	46 (0.4)	47 (0.6)
Czech Republic	67 (0.6) ^a	64 (0.7)	67 (0.8) ^a	61 (1.1)
Denmark	NP	NP	54 (0.6) ^a	48 (0.8)
England and Wales	64 (0.8)	63 (0.6)	63 (1.0)	60 (0.7)
France	NP	NP	55 (0.7) ^a	52 (0.7)
Germany	NP	NP	59 (1.2)	57 (1.0)
Greece	54 (1.0)	53 (1.0)	54 (0.6)	50 (0.6)
Hong Kong	63 (0.8) ^a	61 (0.7)	60 (1.1)	55 (1.1)
Hungary	63 (0.8) ^a	60 (0.7)	63 (0.7)	59 (0.7)
Iceland	56 (0.8) ^a	54 (0.8)	53 (1.2)	51 (0.9)
Iran	41 (1.0)	39 (0.9)	49 (0.8)	45 (0.8)
Ireland	61 (0.7)	61 (0.8)	60 (1.3)	57 (1.0)
Israel	58 (1.1)	57 (0.8)	61 (1.2)	54 (1.1)
Japan	70 (0.4) ^a	69 (0.4)	67 (0.5)	64 (0.4)
Latvia	55 (0.9)	57 (1.0)	52 (0.8)	48 (0.6)
Lithuania	NP	NP	51 (0.8)	47 (0.8)
Netherlands	70 (0.7) ^a	65 (0.7)	64 (1.2)	60 (1.1)
New Zealand	59 (1.2)	61 (0.9)	60 (1.0)	56 (1.0)
Norway	61 (0.8)	60 (0.7)	59 (0.6)	56 (0.4)
Portugal	50 (0.9)	50 (0.8)	52 (0.7)	48 (0.6)
Romania	NP	NP	51 (0.9)	49 (0.9)
Russian Federation	NP	NP	60 (0.9)	57 (0.7)
Scotland	61 (0.9)	60 (0.8)	57 (1.2)	53 (0.9)
Singapore	65 (0.9)	64 (1.0)	71 (1.2)	69 (1.1)
Slovak Republic	NP	NP	62 (0.6)	57 (0.7)
Slovenia	64 (0.7)	63 (0.8)	64 (0.6)	59 (0.7)
South Africa	NP	NP	28 (1.8)	25 (1.2)
South Korea	75 (0.5)ª	73 (0.5)	67 (0.5)	64 (0.5)
Spain	NP	NP	58 (0.5)	54 (0.5)
Sweden	NP	NP	60 (0.6)	57 (0.6)
Switzerland	NP	NP	58 (0.6)	54 (0.5)
Thailand	49 (1.2)	49 (0.8)	57 (0.9)	58 (1.0)
United States	67 (0.6) ^a	49 (0.8) 65 (0.6)	59 (1.0)	57 (1.0)
	0.0)	00 (0.0)	JJ (1.0)	57 (1.0)

 $\mbox{NP} = \mbox{did not participate in grade 4 assessment; TIMSS} = \mbox{Third International Mathematics} \label{eq:normalization}$ and Science Study.

NOTE: Standard errors are shown in parentheses.

 $^{\rm a}\textsc{Difference}$ between the sexes is statistically significant at the 0.05 level, adjusted for multiple comparisons.

SOURCES: A. Beaton, M. Martin, I. Mullis, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1996); and M. Martin, I. Mullis, A. Beaton, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1997).

Appendix table 1-8. Proportion of high school graduates earning credits in mathematics courses, by sex: 1982, 1987, 1990, and 1994 (Percentages)

Year of graduation and sex	Any mathematics	Basic math	General math	Applied math	Prealgebra	Algebra 1	Algebra 2	Geometry	Calculus	AP calculus	Advanced math-other
1982 graduates											
All	98.6 (0.1)	6.2 (0.5)	29.5 (1.1)						_		
Male	98.9 (0.2)	7.4 (0.5)	32.3 (1.2)	10.1 (0.6)	17.5 (1.2)	52.7 (1.0)	35.9 (1.1)		5.2 (0.5)	1.6 (0.3)	14.8 (1.1)
Female	98.4 (0.2)	5.1 (0.7)	26.9 (1.2)	(9.0) 7.7	18.5 (0.8)	55.8 (1.2)	35.3 (0.9)	46.2 (1.2)	4.2 (0.4)	1.4 (0.3)	11.7 (0.7)
1987 graduates											
All	99.8 (0.1)	8.5 (0.7)	21.1 (1.3)								
Male	99.8 (0.1)	9.2 (0.8)	23.1 (1.5)	15.3 (1.2)	17.9 (1.2)	62.3 (1.2)	44.8 (1.8)	58.9 (1.2)	7.4 (0.5)	3.8 (0.5)	22.2 (1.3)
Female	99.7 (0.1)	7.8 (0.8)	19.1 (1.1)	13.6 (1.0)	18.4 (1.2)	65.8 (1.1)	47.5 (1.7)	60.5 (1.0)	4.6 (0.4)	2.7 (0.4)	19.0 (1.2)
1990 graduates											
All	(0.0) 6.66	8.0 (0.7)	19.6 (1.5)								
Male	99.9 (0.1)	8.9 (0.8)	21.6 (1.7)	17.0 (1.3)	23.5 (1.5)	61.4 (1.6)	47.7 (1.4)	62.1 (1.6)	7.5 (0.6)	5.0 (0.6)	21.4 (1.4)
Female	99.9 (0.1)	7.1 (0.7)	17.8 (1.4)	15.2 (1.2)	23.0 (1.4)	66.4 (1.8)	51.5 (1.5)	64.3 (1.4)	5.6 (0.4)	3.4 (0.4)	19.3 (1.1)
1994 graduates											
All	(0.0) 6.66	4.8 (0.5)	16.1 (1.0)								24.7 (0.8)
Male	(0.0) 6.66	5.7 (0.6)	18.2 (1.1)	14.8 (1.1)	24.4 (1.1)	64.7 (1.5)	54.5 (1.5)	(1.5)	9.4 (0.6)	7.1 (0.6)	24.0 (1.0)
Female	(0.0) 6.66	3.9 (0.4)	14.2 (1.1)		22.1 (1.1)						25.3 (1.0)
A D - 20,000,000	+400										

AP = advanced placement

NOTE: Standard errors are shown in parentheses.

SOURCE: National Center for Education Statistics, The 1994 High School Transcript Study Tabulations: Comparative Data on Credits Earned and Demographics for 1994, 1990, 1987, and 1982 High School Graduates, NCES 97-260 (Washington, DC: U.S. Department of Education, 1997).

See figure 1-7.

Appendix table 1-9. Proportion of high school graduates earning credits in mathematics courses, by race/ethnicity: 1982, 1987, 1990, and 1994 (Percentage)

Year of graduation	Anv	Ba	Basic	General	eral	Applied	l pe													Advanced	ced
	mathematics	math	it.	math	£	math	_	Prealgebra	bra	Algebra 1	_	Algebra 2	a 2	Geometry	itry	Calculus		AP calculus	snIns	math-other	other
1982 graduates																					
White	98.8	4.5	(0.4)	25.0	(1.1)		(0.6)		(6.0		(0.1		(6:0			5.5	(0.4)	1.8	(0.3)	4.2	(0.6)
Asian/Pacific Islander	100.0	4.9	(1.6)	17.1	(3.5)		(2.1)		3.4)		5.4)		4.2)			12.8	(2.7)	5.5	(1.7)	9.9	(1.8)
Black	(0.3)	13.6	(2.1)	46.6	(3.1)		(1.5)		2.1)		(8.1		2.0)			1.3	(0.4)	0.3	(0.1)	2.7	(0.5)
Hispanic	97.2 (0.5)	9.4	(1.2)	43.2	(2.1)	11.2	(1.2)	18.5	1.3)	, 9.24	(2)	20.1	1.4)	25.7 (1.7	(0.3)	0.4	(0.1)	3.2	(0.4)
Native American	(9.0) 9.66	7.4	(4.2)	41.4	(5.2)		(3.3)		(2.8)		(6.5)		(4.5)		(7.2)	4.0	(2.2)	0.1	(0.1)	5.5	(3.0)
1987 graduates																					
White	8.66	6.5	(9.0)	18.1	(1.3)	14.3	(1.3)		1.3)		(8.1		1.6)		1.2)	2.7	(0.4)	2.7	(0.3)	4.1	(1.2)
Asian/Pacific Islander	100.0	4.9	(1.3)	14.2	(3.1)	9.7	(1.3)	13.4 (2.8)	63.7 (2.5)	66.1	4.7)	81.4	2.5)	29.6	(4.1)	23.7	(4.7)	5.1	(1.4)
Black	99.8 (0.1)	17.1	(2.7)	37.9	(2.7)	18.4	(1.8)		1.7)		(5.1		1.7)		2.0)	2.2	(0.3)	4.	(0.3)	2.1	(0.6)
Hispanic	(0.1)	21.0	(1.9)	29.3	(3.5)	15.6	(1.8)		2.1)		(8.1		2.0)		1.7)	3.6	(0.7)	5.6	(9.0)	2.1	(0.7)
Native American	99.3 (0.8)	7.2	(1.6)	37.2	(4.7)	29.9	(4.4)		(2.6)		(2.2)		(2.6)		(4.0)	0.4	(0.4)	0.4	(0.4)	4.7	(6.0)
1990 graduates																					
White	(0.1)	5.8	(9.0)	17.5	(1.8)	15.0	(1.1)		1.6)		(6:1		1.6)		1.5)	6.9	(0.5)		(0.5)	2.0	(1.4)
Asian/Pacific Islander	99.9 (0.2)	8.4	(5.6)	14.7	(1.8)	13.0	(3.5)	16.4	2.7)	63.3	3.1)	6.09	(2.0)	7.07	2.8)	18.5	(3.3)	15.6	(2.8)	5.6	(1.1)
Black	(0.1)	14.3	(1.9)	28.4	(2.3)	21.3	(2.7)		2.3)		2.4)		2.8)		2.6)	2.7	(0.5)		(0.3)	6.	(1.0)
Hispanic	99.8 (0.1)	15.3	(2.7)	28.6	(3.0)	19.1	(3.7)		3.2)		2.7)		2.6)		2.8)	3.8	(0.7)		(9.0)	1.6	(0.7)
Native American	100.0 (0.0)	11.1	(3.0)	28.9	(7.0)	20.7	(4.6)		(6.5)		(8.5)		5.4)		(3.1)	4.1	(2.7)		(2.5)	5.9	(1.2)
1994 graduates																					
White	6.66	3.7	(0.5)	14.4	(1.2)		(1.2)		1.1)		(9:1		1.6)		1.6)	9.5	(0.6)		(9.0)		(1.0)
Asian/Pacific Islander	100.0 (0.0)	4.0	(0.9)	17.5	(5.8)	11.4	(3.1)	18.0 ((3.5)	63.0 ((2.1)	66.2 ((2.0)	75.7	(3.8)	23.6	(3.2)	21.1	(5.9)	5.5	(1.6)
Black	100.0 (0.0)	7.3	(1.3)	27.0	(5.9)		(5.0)		2.5)		2.8)		2.4)		3.1)	3.8	(0.0)		(0.4)		(0.3)
Hispanic	(0.1)	8.4	(1.1)	16.2	(1.8)		(1.7)		2.9)		(6.1		1.8)		1.7)	0.9	(0.5)		(0.5)		(0.7)
Native American	100.0 (0.0)	5.4	(1.5)	19.1	(3.4)		(5.9)		8.2)		(6:1		9.8)		4.4)	3.8	(1.2)		(1.4)		(1.6)

AP = advanced placement

NOTE: Standard errors are shown in parentheses.

SOURCE: National Center for Education Statistics, The 1994 High School Transcript Study Tabulations: Comparative Data on Credits Eamed and Demographics for 1994, 1990, 1987, and 1982 High School Graduates, NCES 97-260 (Washington, DC: U.S. Department of Education, 1997).

See figure 1-8.

Appendix table 1-10. Student achievement levels on the National Assessment of Educational Progress in mathematics, by grade, sex, race/ethnicity, and region: 1990, 1992, and 1996

011		Perce	ntage at	or above	e level 2			Perce	entage at	or above	level 3	
Student grade, sex race/ethnicity, and region	1	990	19	992	19	996	19	90	19	992	19	96
					Grade	e 4						
All students	50	(1.4)	59	(1.0)	64 ^{a,b}	(1.2)	13	(1.2)	18	(1.0)	21 ^{a,b}	(0.9)
Male	51	(1.7)	60	(1.1)	65	(1.6)	13	(1.5)	19	(1.1)	24	(1.1)
Female	49	(1.9)	57	(1.6)	63	(1.6)	12	(1.3)	16	(1.3)	19	(1.1)
White	59	(1.7)	70	(1.2)	76	(1.4)	16	(1.6)	23	(1.4)	28	(1.2)
Asian/Pacific Islander	65	(5.4)	75	(3.2)	73	(5.0)	23	(5.6)	30	(4.5)	26	(5.3)
Black	19	(2.4)	23	(1.8)	32	(3.2)	1	(0.6)	3	(0.7)	5	(1.4)
Hispanic	31	(2.6)	35	(2.1)	41	(2.4)	5	(1.1)	5	(1.1)	8	(1.0)
Native American	44	(8.3)	43	(4.8)	52	(2.7)	5	(2.6)	10	(3.6)	8	(2.5)
Northeast	51	(4.2)	63	(2.7)	70	(2.9)	14	(3.4)	23	(2.5)	26	(1.6)
Southeast	40	(2.9)	48	(2.2)	55	(2.9)	8	(1.6)	11	(1.2)	16	(2.4)
Central	55	(2.7)	66	(2.8)	75	(2.6)	14	(1.6)	21	(1.7)	27	(2.1)
West	54	(3.2)	59	(2.1)	58	(2.8)	15	(2.3)	17	(2.2)	18	(1.7)
					Grad	e 8						
All students	52	(1.4)	58	(1.1)	62 ^{a,b}	(1.1)	15	(1.1)	21	(1.0)	24ª	(1.1)
Male	52	(1.9)	57	(1.4)	62	(1.7)	17	(1.5)	21	(1.3)	25	(1.5)
Female	52	(1.5)	58	(1.4)	63	(1.3)	14	(1.1)	21	(1.2)	23	(1.2)
White	61	(1.6)	69	(1.3)	74	(1.3)	19	(1.3)	27	(1.2)	31	(1.4)
Asian/Pacific Islander	71	(5.8)	76	(4.6)	_		32	(5.8)	40	(6.8)	_	_
Black	22	(2.4)	21	(2.0)	28	(2.8)	5	(1.0)	2	(0.7)	4	(0.9)
Hispanic	32	(3.1)	34	(1.9)	39	(2.5)	5	(1.3)	6	(8.0)	9	(1.6)
Native American	33	(10.2)	39	(5.8)	51	(6.2)	6		7	(3.1)	13	(5.0)
Northeast	59	(4.0)	57	(3.5)	67	(3.1)	20	(2.7)	23	(2.5)	27	(3.7)
Southeast	43	(2.6)	50	(1.8)	56	(3.2)	12	(2.1)	15	(1.2)	18	(1.8)
Central	57	(2.5)	66	(2.7)	69	(3.4)	15	(1.3)	25	(2.4)	29	(2.5)
West	50	(2.6)	58	(2.5)	59	(2.2)	15	(2.1)	21	(1.9)	22	(1.9)
					Grade	12						
All students	58	(1.6)	64	(1.1)	69 ^{a,b}	(1.3)	12	(0.9)	15	(0.8)	16ª	(1.1)
Male	60	(1.8)	65	(1.3)	70	(1.4)	15	(1.4)	17	(1.0)	18	(1.3)
Female	56	(1.8)	63	(1.3)	69	(1.5)	9	(0.9)	13	(1.0)	14	(1.2)
White	66	(1.8)	72	(1.3)	79	(1.3)	14	(1.1)	18	(0.9)	20	(1.3)
Asian/Pacific Islander	75	(5.8)	81	(4.3)	81	(4.3)	23	(7.1)	30	(5.6)	33	(6.3)
Black	27	(2.7)	34	(2.6)	38	(3.3)	2	(0.8)	2	(0.5)	4	(1.0)
Hispanic	36	(3.9)	45	(2.0)	50	(3.6)	4	(1.1)	6	(0.9)	6	(1.1)
Native American	_	_ ′	_	_ ′	34	(16.0)	_	_ ′	_	_ ′	3	† /
Northeast	64	(3.1)	66	(2.0)	72	(2.9)	16	(1.9)	18	(1.5)	21	(2.1)
Southeast	47	(3.9)	55	(2.1)	58	(2.6)	6	(0.8)	10	(1.1)	11	(1.5)
Central	62	(3.5)	70	(2.6)	77	(3.6)	13	(1.7)	17	(1.4)	20	(2.8)
West	57	(3.2)	64	(1.7)	69	(2.4)	12	(2.5)	14	(1.6)	14	(1.7)

^{- =} results omitted by source; † = standard error estimate cannot be accurately determined

NOTES: At grade 4, level 2 performance corresponds to average scale scores of 214-248 and level 3 to scores of 249-281. At grade 8, level 2 corresponds to scores of 262-298 and level 3 to scores of 299-332. At grade 12, level 2 corresponds to scores of 288-335 and level 3 to scores of 336-366. Significance levels are reported here only by grade. Race/ethnicity data are based only on those students who indicated their race/ethnicity. Standard errors are shown in parentheses.

SOURCE: C. Reese, K. Miller, J. Mazzeo, and J. Dossey, NAEP 1996 Mathematics Report Card for the Nation and the States (Washington, DC: National Center for Education Statistics, 1997).

See figure 1-10.

^aStatistically significant difference from 1990.

^bStatistically significant difference from 1992.

Appendix table 1-11.

Grade 8 student achievement levels on the National Assessment of Educational Progress in mathematics, by state and race/ethnicity: 1990, 1992, and 1996

			ntage of idents:	:			ntage of students			Percer black s	ntage o tudents		F	Perce lispanio	ntage o studer	
State	ab	t or ove /el 3	ab	or ove el 2	ab	ove	ab	t or ove rel 2	ab	t or ove /el 3	ab	t or ove rel 2	ab	t or ove rel 3	ab	t or oove vel 2
							1990									
Nation	19	1.2	57	1.4	24	1.6	67	1.6	6	1.3	27	3.1	6	1.6	36	3.1
Alabama	12	8.0	47	1.6	16	1.1	59	1.6	3	0.7	23	2.3	4	1.8	20	4.4
Arizona	16	1.1	55	1.8	23	1.5	69	1.6	6	3.2	35	5.3	5	1.0	34	2.4
Arkansas	12	1.0	51	1.3	16	1.2	63	1.6	1	0.6	19	1.1	4	2.8	21	6.3
California	16	1.3	51	1.6	24	2.1	68	1.9	3	1.8	23	3.1	4	0.9	30	2.2
Colorado	22	1.0	64	1.1	27	1.4	73	1.2	2	1.7	28	6.8	6	1.5	40	2.4
Connecticut	26	1.1	66	1.3	31	1.3	75	1.2	5	2.0	33	3.6	5	2.2	30	3.3
Delaware	19	0.9	55	1.3	24	1.2	63	2.0	6	1.2	34	2.2	8	3.5	35	6.7
Florida	15	0.1	49	1.4	19	1.5	61	1.9	3	0.9	22	2.0	10	1.5	37	3.1
Georgia	17	1.3	53	1.5	25	1.8	68	1.6	5	0.8	30	2.0	5	2.2	26	3.7
Hawaii	14	0.8	45	1.0	20	2.7	58	2.6	*		*		5	1.6	23	3.5
Idaho	23	1.4	70	1.2	25	1.6	73	1.3	*		*		7	2.7	42	4.9
Indiana	21	1.2	63	1.6	23	1.2	68	1.5	3	1.4	31	4.5	10	2.8	33	4.7
lowa	30	1.5	76	1.1	32	1.7	78	1.1	*	•••	*	1.0	11	3.6	48	5.7
Kentucky	14	0.9	51	1.8	15	1.1	54	2.0	3	1.5	31	3.5	1	1.2	18	4.6
Louisiana	8	1.0	39	1.7	12	1.6	54	2.0	2	0.5	18	1.9	3	1.6	19	4.1
Maryland	20	1.2	56	1.7	27	1.6	70	1.9	5	1.1	29	2.6	8	1.8	30	3.4
Michigan	20	1.4	60	1.4	24	1.5	69	1.4	1	0.9	18	1.8	6	2.7	35	4.2
Minnesota	29	1.2	74	1.3	30	1.3	77	1.2	10	3.4	30	6.0	6	2.6	33	7.4
Nebraska	30	1.4	74 74	1.1	33	1.5	77 79	1.2	4	3.4	25	5.2	6	2.0	49	6.8
New Hampshire	25	1.2	74 71	1.6	26	1.2	79 72	1.6	*	3.4	23 *	5.2	11	4.6	48	7.4
· · ·	25	1.3	65	1.6	31	1.9	77	1.7	6	1.4	31	2.6	7	1.7	33	2.7
New Jersey New Mexico	13	0.9	51	1.3	23	2.0	77 72	1.7	*	1.4	ا *	2.6	5	0.8	38	1.8
	19	1.0	51 57	1.7	23 26	2.0 1.5	72 72	1.7		1 1	26	/ 1	5 6	1.9	30	4.3
New York									4	1.1		4.1	-			
North Carolina	11	8.0	44 01	1.4	16 36	1.2	58 95	1.9	3	0.9	23	1.9	1	1.0	12	3.9 7.5
North Dakota	34	2.0	81	1.6		2.0	85 66	1.3		1.0		2.0	8	4.5	42	
Ohio	19	1.2	60	1.4	21	1.2	66	1.4	2	1.2	22	3.2	6	3.0	28	7.2
Oklahoma	17	1.3	59	1.6	20	1.5	66	1.8	2	1.1	25	3.0	6	2.5	40	5.8
Pennsylvania	21	1.5	63	2.0	25	1.3	70	1.3	3	2.5	29	4.6	4	2.0	20	4.3
Rhode Island	18	1.0	55	0.9	21	1.2	61	1.0	2	1.4	20	4.2	2	0.9	21	3.7
Texas	16	1.0	52	1.7	26	1.8	71	1.7	3	1.0	23	2.6	6	0.9	36	2.1
Virginia	21	1.6	58	1.6	25	2.0	67	1.7	5	1.1	32	2.5	10	3.7	34	5.0
West Virginia	12	0.9	49	1.2	13	0.9	51	1.2	4	3.3	23	6.1	5	2.7	24	5.3
Wisconsin	29	1.5	72	1.7	32	1.6	79	1.5	4	2.1	24	6.1	8	2.7	42	5.7
Wyoming	24	1.0	71	1.3	26	1.1	74	1.3	*		*		10	2.7	50	3.5

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Appendix table 1-11.

Grade 8 student achievement levels on the National Assessment of Educational Progress in mathematics, by state and race/ethnicity: 1990, 1992, and 1996

		rcentage I students				ntage o			Percer black s	ntage o tudents		Percentage of Hispanic students:			
State	At or above level 3	e a	At or bove evel 2	ab	t or ove rel 3	ab	t or ove rel 2	ab	t or oove vel 3	ab	t or ove vel 2	ab	t or ove rel 3	ab	t or oove vel 2
						1992									
Nation	23 1.	1 61	1.2	30	1.4	73	1.4	3	0.8	26	2.2	7	0.9	37	2.1
Alabama	12 1.	1 44	2.0	19	1.5	59	2.1	1	0.4	19	2.1	1	1.4	15	4.6
Arizona	19 1.4	4 61	1.8	26	1.8	74	1.7	6	2.9	42	7.8	7	1.4	40	3.6
Arkansas	13 1.0	0 50	1.7	17	1.1	61	1.8	2	0.9	18	2.2	5	1.6	23	4.7
California	20 1.4	4 55	2.0	30	2.2	73	2.1	3	1.4	26	5.0	6	1.1	34	2.2
Colorado	26 1.3	3 69	1.3	31	1.5	77	1.2	6	2.8	33	5.8	10	1.3	48	2.6
Connecticut	30 1.	1 69	1.4	38	1.3	81	1.2	5	1.3	32	4.8	6	1.4	32	3.1
Delaware	18 1.	1 57	1.2	25	1.5	69	1.5	4	1.2	31	2.7	5	2.8	33	3.7
Florida	18 1.3			26	1.8	70	1.8	4	0.9	27	2.7	7	1.4	40	4.3
Georgia	16 1.0			23	1.6	69	1.8	4	0.9	29	2.1	5	2.7	27	8.6
Hawaii	16 0.8			22	2.4	62	2.4	*		*	-	5	1.4	34	3.5
Idaho	27 1.2			29	1.2	76	1.1	*		*		9	2.2	46	4.5
Indiana	24 1.3			27	1.5	70	1.6	5	1.9	34	3.9	11	3.8	46	8.0
lowa	37 1.4			39	1.4	83	1.3	*		*		15	3.4	53	5.7
Kentucky	17 1.			18	1.2	61	1.3	5	1.7	30	3.9	5	3.0	26	6.2
Louisiana	10 1.2			16	1.7	59	2.3	2	0.6	22	2.2	2	1.5	21	3.8
Maine	31 1.9			32	2.0	79	1.2	*	0.0	*		*		*	0.0
Maryland	24 1.3			34	1.8	74	1.7	4	1.4	30	2.5	6	2.1	33	4.1
Massachusetts	28 1.4			31	1.6	74	1.6	8	2.7	35	5.3	5	1.8	30	4.5
Michigan	23 1.			29	2.0	75	1.6	2	0.7	22	2.8	11	3.5	44	
Minnesota	37 1.2			39	1.2	81	1.2	*	0.7	*	2.0	8	2.8	48	6.7
Mississippi	8 0.8			16	1.4	59	1.9	1	0.5	19	1.4	1	0.9	12	3.2
Missouri	24 1.3			27	1.4	75	1.4	4	1.3	30	3.1	11	3.6	38	6.4
Nebraska	32 1.9			35	2.0	81	1.2	2	1.3	25	8.1	12	3.4	47	5.9
New Hampshire	30 1.			31	1.4	78	1.0	*	1.0	*	0.1	13	5.6	56	7.1
New Jersey	28 1.4			36	2.0	82	1.3	5	1.4	32	3.8	7	1.9	41	4.3
New Mexico	14 1.0			23	1.8	72	1.6	*	1.4	<u>حر</u>	5.0	6	0.8	40	1.8
New York	24 1.0			32	2.0	72 78	1.4	4	1.6	25	5.2	8	2.1	38	4.9
North Carolina	15 1.0			20	1.2	63	1.6	4	0.8	29	2.8	7	4.2	28	6.1
North Dakota	36 1.			37	1.7	84	1.3	*	0.0	29 *	2.0	*	7.4	<u>د</u> ک *	J. I
Ohio	22 1.4			26	1.6	72	2.0	4	1.0	24	3.0	7	2.6	38	5.6
Oklahoma	21 1.			24	1.2	72	2.2	3	1.1	28	5.2	11	3.6	46	5.4
Pennsylvania	26 1.			29	1.4	72 73	1.4	5 6	4.1	28	5.0	8	3.9	38	5.6
,	20 1.			29	1.4	73 69	1.4	4	3.3	26 32	5.0 4.9	3	3.9 1.4	22	4.3
Rhode Island															
South Carolina	18 1.			27	1.7	70	1.2	4	0.9	30	1.6	2	1.2	21	4.0
Tennessee	15 1.2			18	1.4	62 76	1.5	3	1.0	21	3.1	2	1.8	23	5.8
Texas	21 1.4			32	2.2	76	1.8	7 *	1.5	33	3.0	8	1.0	40	1.9
Utah	27 1.			29	1.2	75	1.3		4.0		0.0	9	2.1	47	3.9
Virginia	23 1.2			28	1.4	71	1.6	6	1.3	35	3.3	13	4.1	50	4.4
West Virginia	13 0.9			13	1.0	55	1.5	5	2.4	31	6.5	2	1.5	19	6.3
Wisconsin	32 1.4			36	1.4	81	1.5	10	5.2	38	9.2	6	2.2	43	6.7
Wyoming	26 1.0	0 73	1.3	28	1.1	77	1.1	*		*		11	2.5	53	4.1

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Appendix table 1-11.

Grade 8 student achievement levels on the National Assessment of Educational Progress in mathematics, by state and race/ethnicity: 1990, 1992, and 1996

		tage of dents:		tage of udents:		itage of tudents:	Percentage of Hispanic students:		
State	At or above level 3	At or above level 2	At or above level 3	At or above level 2	At or above level 3	At or above level 2	At or above level 3	At or above level 2	
				1996					
Nation	23 (1.1)	61 (1.5)	30 (1.5)	73 (1.5)	4 (0.9)	27 (2.9)	8 (1.6)	37 (2.5	
Alabama	12 (1.8)	45 (2.6)	18 (2.7)	63 (3.2)	1 (0.5)	17 (2.0)	6 (2.6)	23 (5.0	
Alaska	30 (1.6)	68 (2.3)	37 (1.9)	77 (2.2)	*	*	13 (4.9)	44 (8.1	
Arizona	18 (1.2)	57 (1.9)	25 (1.7)	72 (1.8)	5 (2.7)	34 (6.2)	6 (1.1)	35 (2.6	
Arkansas	13 (1.0)	52 (1.8)	17 (1.3)	62 (1.8)	2 (0.9)	17 (2.9)	*	*	
California	17 (1.5)	51 (2.1)	28 (2.3)	71 (2.0)	2 †	25 (4.4)	5 (0.8)	32 (2.4	
Colorado	25 (1.3)	67 (1.3)	31 (1.4)	76 (1.2)	8 (3.6)	40 (4.8)	10 (1.5)	43 (3.1	
Connecticut	31 (1.5)	70 (1.4)	37 (1.6)	80 (1.4)	4 (1.5)	29 (3.8)	8 (1.9)	37 (2.5	
Delaware	19 (1.0)	55 (1.3)	24 (1.4)	66 (1.8)	4 (1.2)	27 (4.2)	8 (3.2)	36 (5.5	
Florida	17 (1.3)	54 (2.1)	26 (1.9)	72 (2.3)	3 (1.1)	21 (2.2)	8 (1.6)	39 (2.6	
Georgia	16 (1.8)	51 (2.0)	24 (2.6)	68 (2.1)	3 (0.8)	24 (1.7)	10 (4.2)	36 (6.6	
Hawaii	16 (1.6)	51 (2.0)	22 (3.5)	62 (3.3)	* (0.0)	*	7 (1.6)	33 (3.1	
Indiana	24 (1.7)	68 (2.0)	27 (1.8)	74 (1.9)	2 (1.0)	31 (4.4)	10 (3.1)	44 (7.6	
	` ,	` ,	` ,	(- /	` ,	` ,	10 (5.1)	`	
lowa	- (- /	` ,	` ,	` ,	11 (4.1) 2 [†]	` ,	12 (3.0)	57 (6.3 *	
Kentucky	16 (1.2)	56 (1.6)	17 (1.3)	(- /		- (- /		04 (46	
Louisiana	7 (1.1)	38 (2.0)	12 (1.6)	56 (1.8)	2 (0.5)	17 (2.0)	2 [†]	24 (4.6	
Maine	31 (1.7)	77 (1.5)	32 (1.7)	78 (1.6)	4 (4.0)	00 (0.0)	14 (0.7)	00 /5 0	
Maryland	24 (2.3)	57 (2.2)	34 (2.8)	75 (1.9)	4 (1.0)	26 (2.2)	14 (3.7)	36 (5.2	
Massachusetts	28 (1.8)	68 (2.3)	32 (2.1)	75 (2.0)	8 (3.3)	35 (5.4)	5 (2.2)	26 (5.5	
Michigan	28 (1.8)	67 (2.1)	34 (1.9)	77 (1.7)	5 (2.0)	29 (4.6)	12 (4.6)	37 (5.2	
Minnesota	34 (1.8)	75 (1.5)	37 (1.9)	79 (1.4)	6 (3.5)	33 (7.1)	19 (6.4)	49 (7.7	
Mississippi	7 (0.8)	36 (1.3)	13 (1.6)	56 (1.9)	1 (0.3)	16 (1.3)	3 (1.7)	11 (2.9	
Missouri	22 (1.4)	64 (2.0)	25 (1.6)	70 (2.1)	4 (1.7)	26 (4.7)	10 (4.3)	48 (8.2	
Montana	32 (1.5)	75 (1.7)	36 (1.5)	79 (1.5)	, _ (0.0)		12 (4.1)	52 (6.5	
Nebraska	31 (1.5)	76 (1.1)	34 (1.6)	80 (1.1)	7 (3.3)	40 (4.5)	7 (2.8)	44 (5.6	
New Mexico	14 (1.1)	51 (1.6)	28 (1.8)	72 (2.0)		^ (4.6\	6 (1.2)	38 (1.9	
New York	22 (1.5)	61 (2.0)	31 (1.8)	77 (1.8)	4 (1.8)	32 (4.0)	6 (1.4)	30 (3.6	
North Carolina	20 (1.3)	56 (1.8)	28 (1.6)	69 (1.8)	5 (1.0)	31 (2.5)	7 (2.8)	41 (5.6	
North Dakota	33 (1.5)	77 (1.2)	35 (1.5)	80 (1.1)	*	*	13 (4.9)	55 (8.5	
Oregon	26 (1.6)	67 (1.7)	29 (1.7)	70 (1.6)		*	13 (3.7)	46 (5.3	
Rhode Island	20 (1.3)	60 (1.6)	24 (1.5)	67 (1.6)	7 (3.6)	31 (5.0)	4 (1.4)	27 (5.8	
South Carolina	14 (1.2)	48 (1.7)	22 (2.1)	65 (2.3)	3 (0.6)	28 (1.9)	4 (2.9)	26 (5.6	
Tennessee	15 (1.3)	53 (1.8)	18 (1.5)	62 (2.1)	3 (1.2)	19 (2.9)	6 (2.7)	32 (8.0	
Texas	21 (1.5)	59 (1.8)	33 (1.8)	78 (1.7)	5 (1.7)	31 (4.3)	8 (1.4)	42 (2.6	
Utah	24 (1.3)	70 (1.5)	27 (1.3)	73 (1.3)	*	*	6 (1.8)	45 (4.4	
Vermont	27 (1.4)	72 (1.7)	29 (1.4)	74 (1.6)	*	*	*	*	
Virginia	21 (1.2)	58 (2.0)	28 (1.4)	71 (1.8)	4 (0.8)	26 (3.3)	9 (3.4)	44 (7.3	
Washington	26 (1.2)	67 (1.6)	30 (1.4)	74 (1.5)	5 (2.7)	27 (5.4)	10 (2.8)	36 (4.5	
West Virginia	14 (0.9)	54 (1.6)	15 (0.9)	56 (1.7)	2 †	29 (6.3)	7 (4.2)	30 (6.6	
Wisconsin	32 (2.0)	75 (2.0)	36 (2.0)	82 (1.7)	2 [†]	19 (4.6)	10 (2.9)	45 (6.1	
Wyoming	22 (1.0)	68 (1.2)	24 (1.0)	72 (1.2)	*	*	8 (1.6)	45 (5.0	

^{* =} sample size insufficient to permit reliable estimates; † = standard error estimate cannot be accurately determined

NOTES: At grade 8, level 2 corresponds to scores of 262-298 and level 3 to scores of 299-332. At grade 12, level 2 corresponds to scores of 288-335 and level 3 to scores of 336-366. Idaho, Illinois, Kansas, Nevada, New Hampshire, New Jersey, Ohio, Oklahoma, Pennsylvania, and South Dakota did not participate in the assessment. Standard errors are shown in parentheses. National results are based on the national assessment samples, not on aggregated state assessment program samples.

SOURCE: C. Reese, K. Miller, J. Mazzeo, and J. Dossey, NAEP 1996 Mathematics Report Card for the Nation and the States (Washington, DC: National Center for Education Statistics, 1997).

See figure 1-11.

Appendix table 1-12.

Overall mean and average percentage correct on grade 4 TIMSS mathematics assessment, by country and content area: 1994-95

Country	Mean	All mathematics content areas	Whole numbers	Fractions and propor- tionality	Measure- ment, estimation, and probability	Data rep- resentation, analysis, and probability	Geometry	Patterns, relations, and functions
All countries	529 (5.1)	59 (0.2)	67 (0.2)	49 (0.2)	56 (0.2)	62 (0.2)	64 (0.2)	60 (0.2)
Australia	546 (3.1)	63 (0.6)	67 (0.6)	51 (0.7)	60 (0.7)	67 (0.8)	74 (0.7)	64 (0.9)
Austria	559 (3.1)	65 (0.7)	74 (0.8)	51 (0.8)	69 (0.8)	66 (1.1)	67 (0.8)	64 (1.1)
Canada	532 (3.3)	60 (1.0)	68 (0.9)	48 (1.0)	54 (1.1)	68 (1.4)	72 (1.4)	62 (1.5)
Cyprus	502 (3.1)	54 (0.6)	65 (0.7)	48 (0.7)	48 (0.8)	52 (0.9)	53 (0.9)	55 (1.1)
Czech Republic	567 (3.3)	66 (0.6)	75 (0.6)	53 (0.8)	68 (0.7)	67 (0.9)	71 (0.7)	67 (0.9)
England and Wales	513 (3.2)	57 (0.7)	58 (0.7)	45 (0.8)	52 (0.7)	64 (0.9)	74 (0.8)	55 (1.0)
Greece	592 (4.4)	51 (0.9)	62 (1.0)	42 (1.1)	48 (1.0)	50 (1.2)	53 (1.2)	47 (1.2)
Hong Kong	587 (4.3)	73 (0.9)	79 (0.9)	66 (1.0)	69 (0.9)	76 (1.0)	74 (0.8)	73 (1.2)
Hungary	548 (3.7)	64 (0.8)	76 (0.7)	49 (0.9)	64 (0.9)	60 (1.0)	66 (0.8)	69 (1.1)
Iceland	474 (2.7)	50 (0.8)	56 (0.9)	36 (1.0)	44 (0.9)	58 (1.2)	63 (1.0)	48 (1.4)
Iran	429 (4.0)	38 (0.9)	51 (1.2)	32 (1.0)	36 (0.9)	23 (0.9)	42 (0.9)	40 (1.4)
Ireland	550 (3.4)	63 (0.8)	70 (0.8)	58 (1.0)	56 (0.9)	69 (0.9)	66 (0.8)	64 (1.0)
Israel	531 (3.5)	59 (1.0)	71 (1.0)	48 (1.1)	54 (1.0)	64 (1.2)	62 (1.0)	60 (1.5)
Japan	597 (2.1)	74 (0.4)	82 (0.4)	65 (0.6)	72 (0.5)	79 (0.5)	72 (0.6)	76 (0.6)
Kuwait	400 (2.8)	32 (0.5)	36 (0.5)	25 (0.5)	35 (0.6)	26 (0.6)	36 (0.6)	33 (1.0)
Latvia	525 (4.8)	59 (1.0)	68 (0.9)	44 (1.3)	60 (1.0)	54 (1.3)	67 (1.0)	65 (1.2)
Netherlands	577 (3.4)	69 (0.7)	75 (0.8)	60 (0.9)	70 (0.8)	75 (0.9)	71 (0.8)	65 (1.1)
New Zealand	499 (4.3)	53 (1.0)	57 (1.0)	41 (1.1)	49 (1.1)	61 (1.3)	66 (1.1)	52 (1.2)
Norway	502 (3.0)	53 (0.7)	61 (0.8)	38 (0.7)	56 (0.7)	59 (0.9)	58 (0.9)	50 (1.2)
Portugal	475 (3.5)	48 (0.7)	57 (0.8)	38 (0.7)	49 (0.8)	43 (1.1)	52 (1.0)	47 (1.1)
Scotland	520 (3.9)	58 (0.8)	61 (0.8)	46 (1.0)	53 (0.9)	66 (1.0)	72 (0.8)	57 (1.0)
Singapore	625 (5.3)	76 (0.8)	83 (0.7)	74 (1.0)	67 (1.0)	81 (0.8)	72 (0.8)	76 (0.9)
Slovenia	552 (3.2)	64 (0.6)	74 (0.6)	50 (0.9)	64 (0.9)	64 (1.0)	72 (0.8)	68 (0.8)
South Korea	611 (2.1)	76 (0.4)	88 (0.3)	65 (0.5)	72 (0.5)	80 (0.6)	72 (0.6)	83 (0.7)
Thailand	490 (4.7)	50 (1.1)	58 (1.3)	44 (1.0)	44 (1.0)	56 (1.5)	53 (1.2)	50 (1.3)
United States	545 (3.0)	63 (0.6)	71 (0.7)	51 (0.8)	53 (0.6)	73 (0.9)	71 (0.7)	66 (0.9)

NOTE: Standard errors are shown in parentheses.

SOURCE: I. Mullis, M. Martin, A. Beaton, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1997).

See figure 1-12.

Appendix table 1-13.

Overall mean and average percentage correct on grade 8 TIMSS mathematics assessment, by country and content area: 1994-95

Country	Mean	All mathematic content areas	Fractions s and number sense	Geometry	Algebra	Data representation, analysis, and probability	Measure- ment	Propor- tionality
All countries	513 NI	R 55 (0.1)	58 (0.1)	56 (0.1)	52 (0.2)	62 (0.1)	51 (0.1)	45 (0.2)
Australia	530 (4.0) 58 (0.9)	61 (0.9)	57 (1.0)	55 (1.0)	67 (0.8)	54 (1.0)	47 (0.9)
Austria	539 (3.0) 62 (0.8)	66 (0.8)	57 (1.0)	59 (0.8)	68 (0.8)	62 (1.0)	49 (0.9)
Belgium (Flemish)	565 (5.7	66 (1.4)	71 (1.2)	64 (1.5)	63 (1.7)	73 (1.3)	60 (1.3)	53 (1.8)
Belgium (French)	526 (3.4) 59 (0.9)	62 (1.0)	58 (1.0)	53 (1.1)	68 (1.0)	56 (1.0)	48 (0.9)
Bulgaria	540 (6.3) 60 (1.2)	60 (1.4)	65 (1.3)	62 (1.5)	62 (1.1)	54 (1.6)	47 (1.5)
Canada	527 (2.4	59 (0.5)	64 (0.6)	58 (0.6)	54 (0.7)	69 (0.5)	51 (0.7)	48 (0.7)
Colombia	385 (3.4) 29 (0.8)	31 (0.9)	29 (0.9)	28 (0.9)	37 (1.0)	25 (1.5)	23 (0.9)
Cyprus	474 (1.9) 48 (0.5)	50 (0.6)	47 (0.6)	48 (0.7)	53 (0.6)	44 (0.9)	40 (0.7)
Czech Republic	564 (4.9	66 (1.1)	69 (1.1)	66 (1.1)	65 (1.3)	68 (0.9)	62 (1.2)	52 (1.3)
Denmark	502 (2.8	52 (0.7)	53 (0.9)	54 (0.9)	45 (0.7)	67 (0.9)	49 (1.0)	41 (0.8)
England and Wales	506 (2.6	53 (0.7)	54 (0.8)	54 (1.0)	49 (0.9)	66 (0.7)	50 (0.9)	41 (1.1)
France	538 (2.9	61 (0.8)	64 (0.8)	66 (0.8)	54 (1.0)	71 (0.8)	57 (0.9)	49 (0.9)
Germany	509 (4.5	54 (1.1)	58 (1.1)	51 (1.4)	48 (1.3)	64 (1.2)	51 (1.1)	42 (1.3)
Greece	484 (3.1) 49 (0.7)	53 (0.8)	51 (0.7)	46 (0.8)	56 (0.8)	43 (0.9)	39 (1.1)
Hong Kong	588 (6.5	70 (1.4)	72 (1.4)	73 (1.5)	70 (1.5)	72 (1.3)	65 (1.7)	62 (1.4)
Hungary	537 (3.2	62 (0.7)	65 (0.8)	60 (0.8)	63 (0.9)	66 (0.7)	56 (0.8)	47 (0.9)
Iceland	487 (4.5	50 (1.1)	54 (1.2)	51 (1.4)	40 (1.3)	63 (1.1)	45 (1.4)	38 (1.4)
Iran	528 (2.2	38 (0.6)	39 (0.6)	43 (0.8)	37 (0.8)	41 (0.6)	29 (1.2)	36 (0.8)
Ireland	527 (5.1	59 (1.2)	65 (1.2)	51 (1.3)	53 (1.3)	69 (1.1)	53 (1.3)	51 (1.2)
Israel	522 (6.2	57 (1.3)	60 (1.4)	57 (1.4)	61 (1.6)	63 (1.3)	48 (1.6)	43 (1.6)
Japan	605 (1.9	73 (0.4)	75 (0.4)	80 (0.4)	72 (0.6)	78 (0.4)	67 (0.5)	61 (0.5)
Kuwait	392 (2.5	30 (0.7)	27 (0.8)	38 (1.0)	30 (1.0)	38 (1.0)	23 (1.0)	21 (0.7)
Latvia	493 (3.1	51 (0.8)	53 (0.9)	57 (0.8)	51 (0.9)	56 (0.8)	47 (0.9)	39 (0.9)
Lithuania	477 (3.5	48 (0.9)	51 (1.0)	53 (1.1)	47 (1.2)	52 (1.0)	43 (0.9)	35 (0.9)
Netherlands	541 (6.7	60 (1.6)	62 (1.6)	59 (1.8)	53 (1.6)	72 (1.7)	57 (1.6)	51 (1.9)
New Zealand	508 (4.5	54 (1.0)	57 (1.1)	54 (1.1)	49 (1.1)	66 (1.0)	48 (1.2)	42 (1.0)
Norway	503 (2.2	54 (0.5)	58 (0.6)	51 (0.6)	45 (0.7)	66 (0.6)	51 (0.6)	40 (0.6)
Portugal	454 (2.5	43 (0.7)	44 (0.7)	44 (0.8)	40 (0.8)	54 (0.7)	39 (0.7)	32 (0.8)
Romania	482 (4.0	49 (1.0)	48 (1.0)	52 (0.9)	52 (1.3)	49 (1.0)	48 (1.1)	42 (1.2)
Russian Federation	535 (5.3	60 (1.3)	62 (1.2)	63 (1.4)	63 (1.5)	60 (1.2)	56 (1.5)	48 (1.5)
Scotland	498 (5.5	52 (1.3)	53 (1.3)	52 (1.4)	46 (1.5)	65 (1.3)	48 (1.6)	40 (1.4)
Singapore	643 (4.9	79 (0.9)	84 (0.8)	76 (1.0)	76 (1.1)	79 (0.8)	77 (1.0)	75 (1.0)
Slovak Republic	547 (3.3	, ,	66 (0.8)	63 (0.8)	62 (0.9)	62 (0.7)	60 (0.9)	49 (1.0)
Slovenia	541 (3.1	, ,	63 (0.7)	60 (0.9)	61 (0.8)	66 (0.7)	59 (0.9)	49 (0.8)
South Africa	354 (4.4	, ,	26 (1.4)	24 (1.0)	23 (1.1)	26 (1.2)	18 (1.1)	21 (0.9)
South Korea	607 (2.4	, ,	74 (0.5)	75 (0.6)	69 (0.6)	78 (0.6)	66 (0.7)	62 (0.6)
Spain	487 (2.0	, ,	52 (0.5)	49 (0.6)	54 (0.8)	60 (0.7)	44 (0.7)	40 (0.8)
Sweden	519 (3.0	, ,	62 (0.8)	48 (0.7)	44 (0.9)	70 (0.7)	56 (0.9)	44 (0.9)
Switzerland	545 (2.8	, ,	67 (0.7)	60 (0.8)	53 (0.7)	72 (0.7)	61 (0.8)	52 (0.7)
Thailand	522 (5.7	, ,	60 (1.5)	62 (1.3)	53 (1.7)	63 (1.1)	50 (1.4)	51 (1.5)
United States	500 (4.6	, ,	59 (1.1)	48 (1.2)	51 (1.2)	65 (1.1)	40 (1.1)	42 (1.1)
	(, ()	\/	· - (··)	- : (: :=)	()	- ()	= ()

NR = not reported

NOTE: Standard errors are shown in parentheses.

SOURCE: A. Beaton, I. Mullis, M. Martin, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1996).

See figure 1-13.

Appendix table 1-14. Average percentage correct on TIMSS mathematics assessment, by country, grade, and sex: 1994-95

	Grad	e 4	Grad	de 8
Country	Boys	Girls	Boys	Girls
Australia	63 (0.7)	63 (0.8)	57 (1.2)	59 (1.1)
Austria	66 (0.9)	64 (0.8)	63 (0.8)	61 (1.2)
Belgium (Flemish)	NP	NP	65 (2.0)	66 (1.9)
Belgium (French)	NP	NP	59 (1.1)	58 (1.0)
Canada	61 (1.1)	60 (1.2)	59 (0.7)	59 (0.6)
Colombia	NP	NP	30 (1.6)	29 (0.9)
Cyprus	55 (0.8)	53 (0.7)	47 (0.6)	48 (0.6)
Czech Republic	67 (0.7)	66 (0.7)	67 (1.0)	64 (1.3)
Denmark	NP	NP	54 (0.8) ^a	50 (0.9)
England and Wales	57 (0.8)	56 (0.9)	53 (1.3)	53 (0.9)
France	NP	NP	62 (0.8)	61 (0.9)
Germany	NP	NP	54 (1.3)	54 (1.2)
Greece	50 (1.2)	51 (0.9)	51 (0.9)	48 (0.7)
Hong Kong	73 (1.1)	73 (0.8)	72 (1.7)	68 (1.7)
Hungary	64 (0.8)	64 (0.9)	61 (0.8)	62 (0.8)
Iceland	50 (1.0)	49 (0.9)	49 (1.3)	50 (1.3)
Iran	39 (1.4)	37 (1.1)	39 (0.8)	36 (0.8)
Ireland	63 (0.9)	64 (0.9)	60 (1.6)	58 (1.4)
Israel	60 (1.1)	59 (1.0)	61 (1.5)	55 (1.5)
Japan	75 (0.5)	74 (0.5)	74 (0.5)	73 (0.4)
Latvia	58 (1.2)	60 (1.1)	52 (1.0)	51 (0.8)
Lithuania	NP	NP	48 (1.1)	49 (1.0)
Netherlands	71 (0.8) ^a	68 (0.8)	61 (1.8)	59 (1.6)
New Zealand	52 (1.3)	54 (0.9)	55 (1.4)	53 (1.3)
Norway	54 (0.9)	53 (0.8)	54 (0.6)	53 (0.6)
Portugal	48 (0.8)	48 (0.8)	44 (0.8)	42 (0.7)
Romania	NP	NP	49 (1.1)	49 (1.0)
Russian Federation	NP	NP	59 (1.4)	61 (1.3)
Scotland	58 (0.9)	58 (0.9)	53 (1.7)	50 (1.3)
Singapore	75 (0.9)	76 (1.0)	79 (1.1)	79 (1.0)
Slovak Republic	NP	NP	63 (0.9)	62 (0.8)
Slovenia	64 (0.7)	65 (0.9)	62 (0.8)	60 (0.7)
South Africa	NP	NP	25 (1.7)	22 (1.0)
South Korea	77 (0.4) ^a	75 (0.5)	73 (0.6) ^a	70 (0.7)
Spain	NP	NP	52 (0.7)	50 (0.7)
Sweden	NP	NP	56 (0.8)	56 (0.8)
Switzerland	NP	NP	63 (0.8)	61 (0.7)
Thailand	49 (1.3)	52 (1.0)	56 (1.4)	58 (1.7)
United States	63 (0.7)	62 (0.7)	53 (1.2)	53 (1.1)

NP = did not participate in grade 4 assessment

NOTE: Standard errors are shown in parentheses.

SOURCES: A. Beaton, I. Mullis, M. Martin, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1996); and I. Mullis, M. Martin, A. Beaton, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1997).

^aDifference between the sexes is statistically significant at the 0.05 level, adjusted for multiple comparisons.

Appendix table 1-15.

Students scoring in the top 10th percentile on the TIMSS science and mathematics assessments, by country and grade: 1994-95

	Scie	nce	Mathematics			
Country	Grade 4	Grade 8	Grade 4	Grade 8		
Australia	14 (0.7)	16 (0.9)	12 (0.7)	11 (0.9)		
Austria	10 (0.9)	16 (0.9)	11 (1.1)	11 (0.7)		
Belgium (Flemish)	NP	10 (0.8)	NP	17 (1.2)		
Belgium (French)	NP	1 (0.2)	NP	6 (0.6)		
Bulgaria	NP	21 (1.4)	NP	16 (1.9)		
Canada	9 (0.7)	9 (0.6)	7 (0.8)	7 (0.7)		
Colombia	NP	0 (0.1)	NP	0 (0.0)		
Cyprus	1 (0.1)	1 (0.2)	4 (0.5)	2 (0.3)		
Czech Republic	11 (1.0)	19 (1.6)	15 (1.3)	18 (1.9)		
Denmark	NP	2 (0.3)	NP	4 (0.5)		
England and Wales	13 (1.0)	17 (0.9)	7 (0.7)	7 (0.6)		
France	NP	1 (0.2)	NP	7 (0.8)		
Germany	NP	11 (1.0)	NP	6 (0.7)		
Greece	1 (0.2)	4 (0.4)	3 (0.5)	3 (0.4)		
Hong Kong	4 (0.7)	7 (0.8)	18 (1.5)	27 (2.1)		
Hungary	5 (0.6)	14 (0.8)	11 (1.1)	11 (0.8)		
Iceland	3 (0.4)	2 (0.5)	1 (0.3)	1 (0.3)		
Iran	0 (0.1)	1 (0.1)	0 (0.1)	0 (0.0)		
Ireland	7 (0.6)	12 (0.9)	10 (0.7)	9 (1.0)		
Israel	3 (0.5)	11 (1.2)	6 (0.7)	6 (0.9)		
Japan	11 (0.6)	18 (0.6)	23 (0.9)	32 (0.8)		
Kuwait	0 (0.1)	0 (0.0)	0 (0.1)	0 (0.0)		
Latvia	4 (1.2)	2 (0.3)	6 (1.3)	3 (0.5)		
Lithuania	NP	1 (0.3)	NP	1 (0.3)		
Netherlands	5 (0.6)	12 (1.1)	13 (1.1)	10 (1.6)		
New Zealand	9 (0.9)	11 (0.9)	3 (0.7)	6 (0.8)		
Norway	6 (0.6)	7 (0.5)	2 (0.3)	4 (0.4)		
Portugal	1 (0.2)	1 (0.1)	1 (0.2)	0 (0.1)		
Romania	NP	5 (0.6)	NP	3 (0.4)		
Russian Federation	NP	11 (0.8)	NP	10 (0.7)		
Scotland	9 (0.8)	9 (1.1)	6 (0.8)	5 (0.9)		
Singapore	11 (1.5)	31 (2.3)	39 (2.3)	45 (2.5)		
Slovak Republic	NP	12 (0.9)	NP	12 (1.0)		
Slovenia	6 (0.7)	14 (0.9)	11 (0.9)	11 (0.7)		
South Africa	NP	1 (0.2)	NP	0 (0.0)		
South Korea	17 (0.9)	18 (0.8)	26 (1.2)	34 (1.1)		
Spain	17 (0.3) NP	4 (0.3)	20 (1.2) NP	2 (0.2)		
Sweden	NP	9 (0.6)	NP	5 (0.5)		
Switzerland	NP	7 (0.6)	NP	11 (0.7)		
Thailand	0 (0.1)	4 (0.5)	1 (0.2)	7 (1.2)		
United States	16 (0.1)	13 (0.8)	9 (0.8)	5 (0.6)		
United States	10 (0.9)	13 (0.0)	9 (0.0)	3 (0.0)		

NP = did not participate in grade 4 assessment

SOURCES: A. Beaton, I. Mullis, M. Martin, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1996); and I. Mullis, M. Martin, A. Beaton, E. Gonzalez, D. Kelly, and T. Smith, *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: Boston College, 1997).

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A-26 ◆ Appendix A. Appendix Tables

Appendix table 1-16. Students who report "never or almost never" using computers in science and mathematics courses, by country and grade: 1994-95

	Mathemat	cs: Grade 4	Mathemati	ics: Grade 8	Science	: Grade 8
Country	Percentage of students	Mean TIMSS achievement	Percentage of students	Mean TIMSS achievement	Percentage of students	Mean TIMSS achievement
Australia	66 (4.5)	548 (5.3)	78 (3.2)	531 (5.3)	NA	NA
Austria	98 (1.6)	560 (3.5)	69 (4.5)	551 (5.6)	85 (2.6)	565 (3.1)
Belgium (Flemish)	NA	NA	99 (0.7)	574 (4.6)	98 (1.0)	555 (5.9)
Belgium (French)	NA	NA	95 (2.4)	543 (4.4)	95 (2.0)	483 (3.5)
Canada	58 (4.0)	540 (4.5)	82 (3.5)	533 (2.9)	76 (3.3)	536 (2.9)
Colombia	NA	NA	94 (2.2)	387 (3.8)	95 (2.5)	413 (4.5)
Cyprus	86 (5.1)	508 (4.2)	89 (3.3)	468 (2.9)	92 (1.1)	456 (2.6)
Czech Republic	97 (1.7)	568 (3.3)	74 (5.4)	560 (6.4)	93 (2.0)	573 (4.6)
Denmark	NÀ	NÀ	38 (4.5)	500 (4.5)	63 (5.9)	482 (4.4)
England and Wales	NA	NA	53 (3.9)	517 (5.9)	70 (3.3)	567 (6.9)
France	NA	NA	86 (3.2)	541 (3.3)	97 (1.2)	499 (2.5)
Germany	NA	NA	87 (3.1)	510 (5.8)	95 (1.8)	536 (6.2)
Greece	99 (1.4)	495 (4.1)	85 (2.9)	481 (3.3)	93 (3.2)	498 (2.2)
Hong Kong	99 (0.8)	589 (4.3)	90 (3.5)	590 (7.3)	95 (2.5)	523 (5.3)
Hungary	NA	NA	NA	NA	NA	NA NA
Iceland	NA	NA	NA	NA	73 (6.1)	489 (4.5)
Iran	99 (1.1)	428 (4.1)	93 (5.5)	430 (2.3)	99 (0.5)	469 (2.4)
Ireland	90 (3.2)	549 (3.7)	99 (0.9)	528 (6.0)	96 (1.4)	540 (6.0)
Israel	NA	NA	NA	NA	75 (8.0)	538 (8.3)
Japan	93 (2.3)	598 (2.1)	90 (2.7)	604 (2.5)	84 (2.8)	572 (2.0)
Kuwait	98 (1.3)	401 (3.4)	73 (7.1)	393 (2.9)	78 (7.7)	427 (4.5)
Latvia	95 (2.0)	522 (5.0)	97 (1.6)	490 (3.3)	91 (1.5)	485 (2.6)
Lithuania	NA	NA	94 (1.8)	480 (4.1)	96 (1.1)	477 (4.2)
Netherlands	65 (5.0)	581 (4.9)	NA	NA	85 (2.6)	559 (7.4)
New Zealand	69 (3.8)	499 (4.6)	86(3.1)	506(4.4)	90 (2.7)	526 (4.7)
Norway	80 (3.7)	502 (3.6)	90(2.6)	507(2.7)	96 (1.9)	525 (2.3)
Portugal	98 (1.2)	475 (3.7)	97(1.5)	454(2.6)	99 (0.5)	480 (2.5)
Romania	NA	473 (3.7) NA	96 (1.7)	481 (4.4)	94 (1.3)	487 (4.7)
Russian Federation	NA	NA NA	78 (2.6)	533 (6.8)	88 (1.7)	538 (4.6)
Scotland	NA	NA NA	70 (2.0) NA	NA	NA	NA
	66 (4.2)	627 (5.7)	92 (2.7)	643 (5.3)	95 (1.5)	606 (5.8)
Singapore	NA	027 (3.7) NA	` '	` ,	96 (2.0)	` ,
Slovak Republic			95 (1.5)	543 (3.3)	` ,	546 (3.9)
Slovenia	92 (2.8)	549 (3.5)	69 (4.5)	539 (4.5)	60 (3.1)	556 (3.5)
South Korea	96 (1.7)	610 (2.2)	96 (1.6)	610 (2.5)	96 (1.7)	566 (2.2)
Spain	NA	NA NA	89 (3.1)	488 (2.6)	92 (2.7)	519 (2.1)
Sweden	NA	NA NA	74 (2.9)	519 (4.1)	NA 70 (4.0)	NA
Switzerland	NA	NA	87 (3.2)	549 (5.6)	78 (4.3)	527 (4.9)
Thailand	96 (2.6)	491 (5.3)	97 (2.0)	528 (7.5)	92 (3.6)	530 (5.3)
United States	60 (4.1)	546 (4.7)	76 (3.1)	502 (5.9)	NA	NA

NA = not available; TIMSS = Third International Mathematics and Science Study

NOTE: Standard errors are shown in parentheses.

SOURCES: A. Beaton, I. Mullis, M. Martin, E. Gonzalez, D. Kelly, and T. Smith, Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1996); I. Mullis, M. Martin, A. Beaton, E. Gonzalez, D. Kelly, and T. Smith, Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1997); and A. Beaton, M. Martin, I. Mullis, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1996). A. Beaton, M. Martin, I. Mullis, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1996); and M. Martin, I. Mullis, A. Beaton, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1997).

Appendix table 1-17.

Average number of hours per day students report spending on out-of-school TV and study time, by country and grade: 1994-95

		Grade 4			Gra	de 8	
		Time spent:			Time	spent:	
Country	Watching TV or videos	On math homework or studying	On science homework or studying	Watching TV or videos	Studying or doing homework	On math homework or studying	On science homework or studying
Australia	2.0 (0.05)	0.8 (0.02)	0.4 (0.02)	2.4 (0.05)	2.0 (0.04)	0.7 (0.02)	0.5 (0.01)
Austria	1.4 (0.04)	1.0 (0.03)	0.9 (0.03)	1.9 (0.06)	2.4 (0.07)	0.8 (0.02)	0.7 (0.03)
Belgium (Flemish)	NA ´	NA ´	NA ´	2.0 (0.05)	3.4 (0.07)	1.1 (0.03)	0.8 (0.02)
Belgium (French)	NA	NA	NA	1.9 (0.08)	3.0 (0.07)	1.0 (0.02)	0.8 (0.02)
Canada	1.9 (0.04)	0.8 (0.02)	0.6 (0.03)	2.3 (0.04)	2.2 (0.07)	0.7 (0.02)	0.6 (0.02)
Colombia	NA	NA	NA	2.2 (0.07)	4.6 (0.15)	1.3 (0.06)	1.2 (0.06)
Cyprus	1.8 (0.05)	1.1 (0.03)	0.8 (0.03)	2.3 (0.04)	3.6 (0.06)	1.2 (0.02)	0.9 (0.02)
Czech Republic	1.7 (0.04)	0.7 (0.02)	0.6 (0.02)	2.6 (0.05)	1.8 (0.05)	0.6 (0.02)	0.6 (0.02)
Denmark	NA	NA	NA	2.2 (0.06)	1.4 (0.05)	0.5 (0.02)	0.3 (0.02)
England and Wales	2.2 (0.04)	NA	NA	2.7 (0.07)	NA	NA	NA
France	NA	NA	NA	1.5 (0.04)	2.7 (0.05)	0.9 (0.02)	0.6 (0.01)
Germany	NA	NA	NA	1.9 (0.04)	2.0 (0.05)	0.6 (0.02)	0.6 (0.02)
Greece	1.3 (0.04)	1.6 (0.04)	1.3 (0.03)	2.1 (0.04)	4.4 (0.08)	1.2 (0.03)	1.2 (0.03)
Hong Kong	1.5 (0.04)	1.3 (0.03)	0.9 (0.02)	2.6 (0.05)	2.5 (0.06)	0.9 (0.02)	0.6 (0.02)
Hungary	2.3 (0.05)	1.0 (0.03)	1.0 (0.03)	3.0 (0.06)	3.1 (0.06)	0.8 (0.02)	1.1 (0.02)
Iceland	1.2 (0.04)	0.8 (0.02)	0.3 (0.02)	2.2 (0.05)	2.4 (0.07)	0.9 (0.03)	0.6 (0.03)
Iran	1.3 (0.05)	2.3 (0.07)	2.1 (0.06)	1.8 (0.06)	6.4 (0.13)	2.0 (0.05)	1.9 (0.05)
Ireland	1.9 (0.05)	0.8 (0.02)	0.4 (0.02)	2.1 (0.03)	2.7 (0.05)	0.7 (0.02)	0.6 (0.01)
Israel	2.5 (0.06)	1.1 (0.05)	0.9 (0.04)	3.3 (0.10)	2.8 (0.10)	1.0 (0.04)	0.6 (0.03)
Japan	1.9 (0.03)	0.9 (0.02)	0.4 (0.02)	2.6 (0.04)	2.3 (0.04)	0.8 (0.01)	0.6 (0.01)
Kuwait	1.4 (0.03)	1.9 (0.05)	1.8 (0.05)	1.9 (0.07)	5.3 (0.12)	1.6 (0.04)	1.5 (0.05)
Latvia	2.3 (0.07)	1.0 (0.03)	0.8 (0.03)	2.6 (0.05)	2.7 (0.05)	0.9 (0.02)	0.6 (0.02)
Lithuania	2.5 (0.07) NA	NA	0.8 (0.03) NA	2.8 (0.05)	2.7 (0.06)	0.8 (0.02)	0.7 (0.02)
Netherlands	1.7 (0.06)	0.5 (0.03)	0.4 (0.03)	2.5 (0.09)	2.2 (0.04)	0.6 (0.02)	0.6 (0.01)
New Zealand	2.0 (0.06)	0.8 (0.03)	0.5 (0.02)	2.5 (0.05)	2.1 (0.05)	0.7 (0.02)	0.6 (0.01)
	1.7 (0.04)	0.6 (0.03)	0.4 (0.02)	2.5 (0.03)	2.3 (0.04)	0.7 (0.02)	0.6 (0.01)
Norway Portugal	1.5 (0.05)	1.3 (0.03)	1.3 (0.03)	2.0 (0.04)	3.0 (0.05)	1.0 (0.02)	0.9 (0.02)
Romania	1.5 (0.05) NA	1.3 (0.03) NA	1.5 (0.03) NA		5.0 (0.03)	- (/	1.6 (0.06)
Russian Federation	NA NA	NA NA	NA NA	1.9 (0.06) 2.9 (0.05)	2.9 (0.05)	1.8 (0.07) 0.9 (0.02)	1.0 (0.00)
		0.5 (0.02)	0.3 (0.02)				
Scotland	1.9 (0.06)	` ,	` ,	()	- (/	0.6 (0.02)	(,
Singapore	NA	NA	NA	2.7 (0.05)	4.6 (0.04)	1.4 (0.02)	1.3 (0.02)
Slovak Republic	NA 1.5 (0.04)	NA 1.0 (0.03)	NA 1 0 (0.03)	2.7 (0.05)	2.4 (0.04)	0.7 (0.01)	0.8 (0.02)
Slovenia	1.5 (0.04)	1.0 (0.03)	1.0 (0.03)	2.0 (0.04)	2.9 (0.05)	0.9 (0.02)	1.0 (0.02)
South Korea	1.5 (0.03)	1.0 (0.02)	0.8 (0.02)	2.0 (0.04)	2.5 (0.05)	0.8 (0.02)	0.6 (0.02)
Spain	NA NA	NA	NA	1.8 (0.05)	3.6 (0.06)	1.2 (0.02)	1.0 (0.02)
Sweden	NA	NA	NA	2.3 (0.04)	2.3 (0.04)	0.7 (0.01)	0.7 (0.01)
Switzerland	NA	NA	NA	1.3 (0.03)	2.7 (0.04)	0.9 (0.02)	0.7 (0.01)
Thailand	1.1 (0.09)	1.0 (0.03)	0.7 (0.03)	2.1 (0.07)	3.5 (0.06)	1.2 (0.03)	1.0 (0.02)
United States	2.0 (0.04)	1.0 (0.03)	0.8 (0.02)	2.6 (0.07)	2.3 (0.04)	0.8 (0.02)	0.6 (0.01)

NA = not available

NOTE: Standard errors are shown in parentheses.

SOURCES: A. Beaton, M. Martin, I. Mullis, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1996); M. Martin, I. Mullis, A. Beaton, E. Gonzalez, T. Smith, and D. Kelly, Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1997); A. Beaton, I. Mullis, M. Martin, E. Gonzalez, D. Kelly, and T. Smith, Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1996); and I. Mullis, M. Martin, A. Beaton, E. Gonzalez, D. Kelly, and T. Smith, Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS) (Chestnut Hill, MA: Boston College, 1997).

See figure 1-16.

Appendix table 1-18. **Grade 8 teachers' beliefs about the nature and teaching of mathematics and science: 1994-95** (Percentages)

Belief		ngly gree	Disa	gree	Agı	ree	Stron agre	0,	-	strongly ree ^a
	N	athem	atics							
Math is primarily an abstract subject	11.7	(2.6)	57.3	(4.6)	28.9	(3.9)	2.2 ((0.9)	31.0	(3.9)
Math is primarily a formal way of representing		<i>(-</i> -)				,,				
the real world	1.0	(8.0)	19.9	(3.7)	67.9	(3.9)	11.2((2.4)	79.1	(3.7)
Math is primarily a practical and structured guide		(0.0)	44.0	(0, 0)	00.5	(O. 4)	400	(o =)	00.0	(0, 0)
for addressing real situations	0.0	(0.0)	11.2	(2.0)	69.5	(3.4)	19.3 ((2.7)	88.8	(2.0)
f students are having difficulty, an effective										
approach is to give them more practice by	20.1	(2.6)	57 G	(A E)	10.5	(2.0)	20 /	(O O)	22.4	(2.0)
themselves during the class	20.1	(3.6)	57.0	(4.5)	19.5	(3.2)	2.9 ((0.9)	22.4	(3.0)
and others do not	3.5	(1.4)	15.0	(2.4)	64.2	(3.8)	17.2 ((3.4)	81.4	(2.8)
Nore than one representation should be used in	0.0	(1.7)	10.0	(2.7)	04.2	(0.0)	17.2 ((υ.¬)	01.4	(2.0)
teaching a math topic	0.0	(0.0)	1.7	(1.0)	46.6	(3.9)	51.7 ((3.7)	98.3	(1.0)
Math should be learned as sets of algorithms or	0.0	(0.0)	• • • • • • • • • • • • • • • • • • • •	()	.0.0	(0.0)	· · · · · ·	(3)	00.0	()
rules that cover all possibilities	10.9	(2.4)	53.9	(3.8)	32.6	(3.4)	2.6 ((0.9)	35.2	(3.6)
Basic computational skills on the part of the		,		,		` ,	,	,		,
teacher are sufficient for teaching elementary										
school math	42.3	(3.7)	40.4	(3.6)	11.5	(3.3)	5.8 ((1.7)	17.3	(3.8)
A liking for and understanding of students are										
essential for teaching math	0.8	(0.3)	2.6	(1.0)	40.9	(4.2)	55.7 ((4.1)	96.5	(1.1)
		Scien	се							
Science is primarily an abstract subject	17.9	(2.1)	63.9	(3.2)	18.1	(3.2)	0.1 ((0.1)	18.2	(3.2)
Science is primarily a formal way of representing										
the real world	1.4	(8.0)	14.3	(2.3)	69.7	(4.3)	14.7 ((3.6)	84.3	(2.6)
Science is primarily a practical and structured										
guide for addressing real situations	0.0	(0.0)	12.0	(2.9)	66.0	(4.6)	22.0 ((3.8)	88.0	(2.9)
Some students have a natural talent for science										
and others do not	6.3	(1.5)	31.8	(3.8)	51.8	(3.7)	10.2 ((2.8)	62.0	(3.2)
t is important for teachers to give students										
prescriptive and sequential directions for	0.0	(4.0)	00.0	(0.1)	40.0	/F 4\	071	(4.0)	75.0	(0, 0)
science experiments	3.3	(1.3)	20.8	(3.1)	48.9	(5.1)	27.1 ((4.0)	75.8	(3.6)
ocusing on rules is a bad idea. It gives students the impression that the sciences are										
a set of procedures to be memorized	153	(2.9)	52.7	(4.8)	26.1	(3.2)	5.9 ('2 Q\	32.0	(3.7)
students get into debates in class about ideas	10.0	(2.5)	52.1	(4.0)	20.1	(0.2)	5.5 ((2.5)	02.0	(0.7)
or procedures covering the sciences, it can										
harm their learning	56.5	(3.7)	40.7	(3.8)	0.7	(0.7)	2.1 ((1.8)	2.8	(1.9)
Students see a science task as the same task		()		·/	- '	, ,	\	- /		` '/
when it is represented in two different ways	4.6	(1.5)	52.6	(3.9)	41.9	(4.2)	0.8 ((0.4)	42.8	(4.2)
A liking for and understanding of students are		` ,		` '		` '	•	,		` '
essential for teaching science	1.3	(8.0)	9.1	(2.7)	43.2	(3.6)	46.4 ((4.0)	89.6	(2.7)

NOTES: Data reflect the beliefs of grade 8 mathematics and science teachers surveyed as part of the Third International Mathematics and Science Study. Responses are to the question: "To what extent do you agree or disagree with each of the following statements?" Standard errors are shown in parentheses. Details may not add to totals because of rounding.

SOURCE: T. Williams, D. Levine, L. Martin, P. Butler, C. Heid, and J. Haynes, *Mathematics and Science in the Eighth Grade*, report prepared for the National Center for Education Statistics (Rockville, MD: Westat, Inc., 1997).

See figure 1-19.

^aData in this column reflect the combined categories "Agree" and "Strongly agree."

Appendix table 1-19.

Grade 8 teachers' perceptions of student skills required for success in mathematics and science: 1994-95

(Percentages)

Skill		Not ortant		ewhat ertant		ery ortant
Mathematics						
Remember formulas and procedures	3.0	(1.1)	54.0	(3.5)	43.0	(3.5)
Think in sequential manner	0.6	(0.6)	20.0	(2.7)	79.5	(2.8)
Understand concepts	0.0	(0.0)	11.1	(3.0)	88.9	(3.0)
Think creatively	2.0	(0.9)	32.7	(3.8)	65.4	(4.0)
Understand math use in real world	0.0	(0.0)	18.3	(2.7)	81.7	(2.7)
Support solutions	2.4	(2.4)	16.9	(3.3)	80.8	(4.1)
Science						
Remember formulas and procedures	10.8	(2.4)	63.7	(4.1)	25.5	(4.0)
Think in sequential manner	1.3	(0.9)	19.1	(2.5)	79.6	(2.9)
Understand concepts	0.7	(0.7)	15.4	(2.4)	84.0	(2.5)
Think creatively	0.2	(0.2)	26.7	(3.6)	73.0	(3.7)
Understand science use in real world	0.3	(0.3)	20.5	(3.4)	79.2	(3.5)
Support solutions	0.0	(0.0)	13.9	(3.0)	86.1	(3.0)

NOTES: Data reflect the beliefs of grade 8 mathematics and science teachers surveyed as part of the Third International Mathematics and Science Study. Responses are to the statement: "To be good at mathematics [science] at school, how important do you think it is for students to...?" Standard errors are shown in parentheses. Details may not add to totals because of rounding.

SOURCE: T. Williams, D. Levine, L. Martin, P. Butler, C. Heid, and J. Haynes, *Mathematics and Science in the Eighth Grade*, report prepared for the National Center for Education Statistics, (Rockville, MD: Westat, Inc., 1997).

See figure 1-20.

Appendix table 1-20. Requirements for state teacher license: 1996

State	Major in subject field ^a	Written test	Performance assessment ^b
	-		
Alabama	No	-	-
Alaska	Yes	-	Yes
Arizona		_	-
Arkansas		Yes	_
California	Yes	Yes	-
Colorado		Yes	Yes
Connecticut		Yes	Yes
Delaware	No	Yes	-
Florida		Yes	Yes
Georgia		Yes	_
Hawaii	Yes	Yes	-
Idaho		_	-
Illinois		Yes	-
Indiana	Yes	Yes	-
lowa		_	-
Kansas		Yes	-
Kentucky	Yes	Yes	Yes
Louisiana			_
Maine		Yes	-
Maryland	No	Yes	Yes
Massachusetts		Yes	_
Michigan		Yes	Yes
Minnesota		Yes	_
Mississippi		Yes	Yes
Missouri		Yes	Yes
Montana	No	Yes	_
Nebraska		Yes	_
Nevada		Yes	_
New Hampshire	Yes ^c	_	_
New Jersey		-	_
New Mexico		Yes	_
New York	No	Yes	Yes
North Carolina		Yes	Yes
North Dakota		-	Yes
Ohio	No	Yes	Yes
Oklahoma		Yes	_
Oregon		Yes	Yes
Pennsylvania		Yes	_
Rhode Island		-	_
South Carolina	Yes	Yes	Yes
South Dakota	Yes	-	Yes
Tennessee	Yes	_	_
Texas	Yes ^c	Yes	_
Utah		_	_
Vermont		. -	-
Virginia		Yes	-
Washington	No	-	Yes
West Virginia		Yes	-
Wisconsin		Yes	Yes
Wyoming	Yes	-	_

^{- =} data not available

SOURCE: Council of Chief State School Officers, Key State Education Policies on K-12 Education: Content Standards, Graduation, Teacher Licensure, Time and Attendance (Washington, DC: 1996).

 $^{^{\}rm a}{\rm A}$ major in education is not accepted. "Yes" denotes that a subject major is required for middle and/or secondary teaching license.

^bPerformance assessment comprises one or more of the following techniques: portfolios, classroom observations, simulated exercises.

[°]A subject major is required for all teachers K-12, not just for middle/secondary teachers.

Appendix table 1-21. National trends in science coursetaking at age 17, by sex and race/ethnicity: 1986, 1990, 1992, and 1994

	F	Total	Ma	Male	Female	ale	White	te	Black		Hispanic	U
Course and year	Average NAEP science scale score	Percentage of students	Average NAEP science scale score	Percentage of students								
General science												
1986												
1990	292 (1.1)	82 (1.3)	298 (1.4)	84 (1.3)	286 (1.4)	81 (1.7)		84 (1.4)	258 (4.5)	76 (3.1)	266 (4.8)	82 (4.4)
1992												
1994	296 (1.6)⁵	83 (1.3)	302 (2.2)	84 (1.5)	291 (1.8) ^b	82 (1.4)	306 (1.7)⁵	84 (1.5)	259 (3.3)	80 (1.9)		77 (2.4)
Biology 1986												
1990	296 (1.0)ª	89 (0.9)ª	302 (1.3)	$87 (1.1)^a$	290 (1.5)	91 (1.0)	$304 (1.0)^a$	90 (0.9)ª	260 (4.6)	87 (2.2)	270 (5.0)	79 (4.4)
1992												
1994						93 (1.0)⁵	310 (1.3) ^b	94 (0.9) ^b		93 (1.8)⁵		84 (3.4)
Chemistry 1986												
1990												
1992	319 (1.0)⁵	49 (1.7) ^b	325 (1.5)	47 (1.9)	313 (1.5) ^b	51 (2.0) ^b	325 (1.3)⁵	52 (1.8) ^b	282 (3.6)	36 (3.2) ^a	298 (4.1)	36 (5.6)
1994	315 (1.7)	53 (2.1) ^b	322 (2.4)	50 (2.6) ^b	309 (1.9)	55 (2.3)⁵	324 (1.7) ^b	54 (2.5) ^b		51 (3.6) ^b		41 (3.0) ^b
Physics									!	:	1	
1986									$239 (5.4)^a$	2	257 (17.6)	
1990	304 (3.7)								263 (11.8)	15	253 (18.3)	17 (4.5)
1992	306 (3.9)	$14 (1.1)^a$	310 (4.7)	$15 (1.0)^a$	302 (4.1) ^b	12 (1.5)	319 (3.5)	$13 (1.2)^a$	251 (7.4)	14 (1.9)	282 (11.1)	13 (2.3)
1994	314 (2.9) ^b	18 (1.2) ^b							268 (7.5) [†]	16	*	*

^{* =} sample size insufficient to permit reliable estimates; NAEP = National Assessment of Educational Progress

NOTES: Scale scores range from 0 to 300. Significance tests for extreme percentages (either >90 or <10 percent) should be interpreted with caution. It can be said with 95 percent certainty that for each population of interest, the value for the whole population is within ±2 standard errors of the estimate for the sample. Use the standard error of difference in comparing estimates. Details may not add to totals because of

^aStatistically significant difference from 1994 at the 0.05 level, adjusted for multiple comparisons.

bStatistically significant difference from 1986 at the 0.05 level, adjusted for multiple comparisons.

SOURCE: J. Campbell, C. Reese, C. O'Sullivan, and J. Dossey, NAEP 1994: Trends in Academic Progress (Washington, DC: National Center for Education Statistics, 1996).

Appendix table 1-22. Highest level of mathematics courses taken at age 17, by sex and race/ethnicity: 1978 and 1994

	<u> </u>	Total	2	Male	Female	ale	Wh	White	Black	<u>×</u>	Hispanic	lic l
Course and year	Average NAEP math scale score	Percentage of students	Average NAEP math scale score	Percentage of students	Average NAEP math scale score	Percentage of students	Average NAEP math scale score	Percentage of students	Average NAEP math scale score	Percentage of students	Average NAEP math scale score	Percentage of students
Prealgebra or general mathematics 1978	267 (0.8)	20 (1.0) ^a	269 (1.0) ^a	21 (1.0) ^a	265 (0.9)	20 (1.1) ^a	272 (0.6)	18 (1.1) ^a	247 (1.6) ^a	31 (1.3)	256 (2.3)ª	36 (3.1)
Algebra 1 1978		9 (1.1) 17 (0.6) 15 (0.9)	289 (0.9) 289 (1.6)			0 (1.2) 18 (0.7) ^a 14 (0.9)		9 (1.1) 17 (0.6) ^a 14 (0.9)	264 (1.5) ^a 275 (3.3)	19 (1.2)	273 (2.8)ª	19 (2.1)
Geometry 1978 1994											294 (4.4)	12 (1.2)
Algebra 2 1978	321 (0.7) ^a 316 (1.0)	37 (1.2) ^a 47 (1.6)	325 (0.8) ^a 320 (1.5)	38 (1.2) ^a 44 (1.9)	318 (0.9) ^a 313 (1.1)	37 (1.3) ^a 50 (2.0)	325 (0.6) ^a 320 (1.0)	39 (1.3) ^a 48 (1.9)	292 (1.4) 297 (2.5)	28 (2.1) ^a 45 (3.4)	303 (2.9) 304 (4.1)	23 (2.5) ^a 38 (3.5)
Precalculus or calculus or 1978	334 (1.4) ^a 340 (2.2)	6 (0.4) ^a 13 (1.2)	337 (2.0) 343 (2.6)	7 (0.5) ^a 13 (1.3)	329 (1.8)ª 337 (2.8)	4 (0.4) ^a 12 (1.5)	338 (1.1) ^a 344 (2.0)	6 (0.4) ^a 14 (1.5)	297 (6.5)ª	4 (0.6)	306 (6.1)	3 (0.9)

^{* =} sample size insufficient to permit reliable estimates

NOTES: It can be said with 95 percent certainty that for each population of interest, the value for the whole population is within ±2 standard errors of the estimate for the sample. Use the standard error of difference in comparing estimates. Details may not add to totals because a small percentage of students reported having taken other mathematics courses. Standard errors are shown in parentheses.

eStatistically significant difference between 1994 and the earliest year with available data at the 0.05 level; this is not adjusted for multiple comparisons.

SOURCE: J. Campbell, C. Reese, C. O'Sullivan, and J. Dossey, NAEP 1994: Trends in Academic Progress (Washington, DC: National Center for Education Statistics, 1996).

Appendix table 1-23. Frequency of calculator use in grade 8 mathematics and science classes, by type of activity: 1994-95 (Percentage of teachers reporting)

Activity	Hardl	y ever		or twice onth	Once or a we		Ever	y day
Mathematics								
Checking answers	17.4	(3.3)	10.8	(2.3)	16.4	(3.2)	55.4	(4.6)
Tests and exams	31.0	(3.9)	22.9	(3.7)	21.8	(3.4)	24.3	(4.6)
Routine computation	22.9	(3.6)	8.9	(2.2)	16.1	(3.0)	52.1	(5.1)
Solving complex problems	11.4	(2.5)	12.2	(2.3)	23.0	(3.8)	53.4	(4.7)
Exploring number concepts	23.6	(2.9)	17.6	(3.0)	22.7	(3.9)	36.1	(3.6)
Science								
Checking answers	50.8	(3.4)	29.7	(3.8)	17.2	(3.3)	2.3	(1.2)
Tests and exams	67.7	(3.5)	22.6	(3.0)	6.4	(2.2)	3.3	(1.4)
Routine computation	39.3	(4.0)	33.0	(4.5)	19.7	(3.2)	8.0	(1.8)
Solving complex problems	46.7	(3.7)	35.1	(3.9)	14.4	(3.3)	3.9	(1.3)
Exploring number concepts	68.7	(3.8)	19.6	(3.6)	10.4	(2.7)	1.4	(0.4)

NOTE: Percentages may not total 100 because of rounding. Standard errors are shown in parentheses.

SOURCE: T. Williams, D. Levine, L. Martin, P. Butler, C. Heid, and J. Haynes, *Mathematics and Science in the Eighth Grade,* report prepared for the National Center for Education Statistics (Rockville, MD: Westat, Inc., 1997).

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Appendix table 1-24.

Percentage of public secondary school students taught by teachers without at least a minor in the field, by field and selected classroom characteristics: 1990-91

				Science		Social	studies
Characteristic	English	Math	All sciences	Life science	Physical science	All social studies	History
Total	20.8	26.6	16.5	38.5	56.2	13.4	53.9
Achievement level of class							
Low achievement	28.2	33.7	26.6	48.7	66.7	18.4	60.1
Average achievement	19.0	25.6	15.2	33.7	58.0	12.5	52.1
High achievement	16.3	21.6	9.2	32.0	45.5	11.8	52.6
Type or track of class							
Low-track	24.7	33.5	20.4	42.3	66.8	14.3	55.1
Medium-track	11.8	15.7	9.2*	31.4	42.8	8.9	44.9
High-track	11.2	20.4*	7.2*	20.7	43.0	11.2	51.1
Minority enrollment of class							
Low minority	19.2	22.7	14.6	36.6	56.3	12.3	55.6
Medium minority	19.9	24.2	17.7	42.8	54.1	15.0	52.7
High minority	25.2	36.1	19.6	37.6	58.7	14.3	51.4
Grade level of class							
7th grade	32.2	48.8	31.8	60.4	73.8	23.9	56.3
8th grade	32.9	37.1	23.8	32.9*	75.7	19.7	60.5
9th grade	15.7	18.1	10.7	27.9	61.7	8.7	48.7
10th grade	11.1	16.8	8.9*	29.3	45.7	8.8	51.1
11th grade	11.2	15.9	6.4	23.5*	36.8	6.8	47.0
12th grade	13.9	24.2	13.1*	25.3*	41.0	11.3	62.4

^{*}Coefficient of variation greater than 30 percent.

NOTE: The estimates for life science, physical science, and history represent the proportion of students taught by teachers without at least a minor in those particular subfields.

SOURCE: R. Ingersoll, Out-of-Field Teaching and Educational Equality, NCES 96-040. (Washington, DC: U.S. Department of Education, 1996).

Appendix table 1-25.

Percentage of public schools and instructional rooms with Internet access, by school characteristics: 1994-96

			-	e of scho net acce					•	instructio ernet acc		ms
Characteristic	19	994	1	995	1	996	1	994	19	995	19	996
All public schools	35	(1.5)	50	(1.8)	65	(1.8)	3	(0.3)	8	(0.7)	14	(1.0)
Instructional level												
Elementary	30	(1.9)	46	(2.4)	61	(2.1)	3	(0.4)	8	(1.0)	13	1.5)
Secondary	49	(2.4)	65	(2.7)	77	(1.8)	4	(0.6)	8	(1.0)	16	(1.5)
Percent minority enrollment												
Less than 6 percent	_	_	52	(3.3)	65	(3.4)	_	_	9	(1.4)	18	(2.4)
6 to 20 percent	-	_	58	(4.4)	72	(3.0)	_	_	10	(1.5)	18	(2.2)
21 to 49 percent	-	_	54	(4.0)	65	(3.2)	_	_	9	(2.1)	12	(2.3)
50 percent or more	-	_	40	(3.8)	56	(4.6)	_	_	3	(1.0)	5	(1.5)
Percent of students eligible for free or reduced-price school lunch												
Less than 11 percent	_	_	62	(3.5)	78	(3.6)	_	_	9	(1.6)	18	(2.9)
11 to 30 percent	_	_	59	(3.6)	72	(3.1)	_	_	10	(1.8)	16	(2.0)
31 to 70 percent	-	_	47	(2.9)	58	(3.2)	_	-	7	(1.6)	14	(1.8)
71 percent or more	_	_	31	(4.3)	53	(5.2)	_	_	3	(0.9)	7	(1.6)

^{- =} data not available

NOTE: Instructional rooms include classrooms, computer and other labs, and library/media centers. Standard errors are shown in parentheses.

SOURCE: National Center for Education Statistics, "Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, Fall 1996," Statistics in Brief, NCES 97-944 (Washington, DC: U.S. Department of Education, 1997).

See figure 1-17.

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Appendix table 1-26. Proficiency of grade 8 mathematics students, by teachers' backgrounds in mathematics: 1988

	Teachers have calculus or b		Teachers hav advanced mat	
Student proficiency level	And have no math- ematics education	And have a math- ematics education	And have no math- ematics education	
Unable to perform simple mathematics operations on whole numbers	. 22	21	17	16
Able to perform simple arithmetic operations on whole numbers	. 40	43	39	37
Able to perform simple arithmetic operations with decimals, fractions and roots	. 21	24	21	25
Able to perform simple problem solving	. 17	13	22	22

SOURCE: B. Chaney, Student Outcomes and the Professional Preparation of Eighth Grade Teachers in Science and Mathematics, report prepared for the National Science Foundation (Rockville, MD: Westat, Inc., 1995).

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Appendix table 1-27. Trends in average scale scores on the National Assessment of Educational Progress in mathematics, by age, sex, and race/ethnicity: 1973-96, selected years

	All students	Males	Females	Difference, male vs. female	Whites	Blacks	Difference, white vs. black	Hispanics	Difference, white vs. Hispanic
Age 9									
19/3									
1978									
1982									
1986									
1990									
1992	230 (0.8)	231 (1.0)	228 (1.0)	2 (1.4)	235 (0.8)	208 (2.0)	27 (2.2)	212 (2.3)	23 (2.5)
1994									
1996		233 (1.2)							
Age 13									
1973									
1978									
1982									
1986									
1990									
1992									
1994	274 (1.0)	276 (1.3)	273 (1.0)	3 (1.6)	281 (0.9)	252 (3.5)	29 (3.7)	256 (1.9)	25 (2.1)
1996		276 (0.9)							
Age 17									
1973		309 (1.2)		ワ					
1978				こ					
1982				こ					
1986				こ					
1990				こ					
1992	307 (0.9)	309 (1.1)	305 (1.1)	4 (1.5)	312 (0.8)	286 (2.2)	26 (2.4))	292 (2.6)	20 (2.8)
1994				こ					
1996				T)	313 (1.4)				

NOTES: Scale scores range from 0 to 300 for every grade level. Standard errors are shown in parentheses.

SOURCE: J. Campbell, C. Reese, C. O'Sullivan, and J. Dossey, NAEP 1994: Trends in Academic Progress (Washington, DC: National Center for Education Statistics, 1996).

See figure 1-9.

Appendix table 2-1. Number of first university degrees and percentage of 24-year-olds who earn first university degrees in S&E, by region/country: Most recent year

			Degree field	s		24-yea	r-olds	
Region/country	All first university	Natural	Social sciences ^b	Engineering	Total	% with first univ.	% with NS&E	% with
	degrees	sciences ^a		Engineering	number	degree	degree	degree
Total, three world regions	5,208,205	764,820	642,777 Asia	739,051	64,944,472	8.0	2.3	1.0
[otol	2,043,677	201 077		242 774	10 512 016	4.2	1.2	0.6
Total China	325,484	301,877 54,394	280,775 32,075	343,774 148,844	48,543,046 24,413,600	1.3	1.3 0.8	0.6 0.1
Hong Kong	11,362	2,370	1,233	1,822	92,634	12.3	4.5	1.3
India	750,000	147,036	NA	29,000	15,545,800	4.8	1.1	NA
Indonesia	78,655	11,024	13,959	9,813	3,660,449	2.1	0.6	0.4
Japan	493,277	30,579	200,875	97,392	1,996,800	24.7	6.4	10.1
Malaysia	10,511	1,685	2,198	877	333,180	3.2	0.8	0.7
Singapore	5,599	2,103	1,820	1,676	50,000	11.2	7.6	3.6
South Korea	184,214	31,946	16,955	35,449	890,800	20.7	7.6	1.9
Taiwan	68,274	10,131	4,848	12,107	348,400	19.6	6.4	1.4
Thailand	116,301	10,609	6,812	6,794	1,211,383	9.6	1.4	0.6
			Europe					
Total	1,713,423	309,837	138,896	283,530	10,479,620	16.4	5.7	1.3
European Union	982,939	149,180	77,532	132,101	5,674,706	17.3	5.0	1.4
Austria (long)	11,513	1,875	912	1,180	112,935	10.2	2.7	0.8
Belgium (long)	20,484	1,779	5,409	4,505	138,677	14.8	4.5	3.9
Denmark (short)	16,833	625	1,202	2,243	75,298	29.5	6.5	1.9
Denmark (long)	5,395	864	262	1,139				
Finland (short)	4,655	714	NA	2,325	63,174	22.4	9.0	1.3
Finland (long)	9,467	1,433	807	1,219				
France (long)	108,900	21,993	NA	20,562	855,915	12.7	5.0	NA
Germany (short)	71,367	12,224	10,101	25,502	1,354,866	14.5	5.8	1.4
Germany (long)	125,706	25,714	8,596	15,052				
Greece (long)	18,556	2,570	221	1,785	151,822	12.2	2.9	0.1
Ireland (short)	8,174	863	541	414	64,385	21.9	6.3	1.8
Ireland (long)	5,943	1,672	635	1,135				
Italy (short)	6,847	522	1,054	261	897,248	11.5	2.5	1.2
Italy (long)	96,278	12,563	9,371	8,755	000 504	40.0		0.0
The Netherlands (long)	45,478	3,117	7,588	6,917	228,501	19.9	4.4	3.3
Portugal (short)	3,007	47	7	340	164,199	13.7	2.6	1.6
Portugal (long)	19,495	1,712	2,639	2,128	050 040	00.0	0.7	0.0
Spain (short)	55,819	2,537	NA 5 71 4	6,720	659,319	20.9	3.7	0.9
Spain (long)	82,004	11,267	5,714	4,097	104 567	10.7	0.0	4.4
Sweden (short)	8,126	785 867	1,141 171	135 2,369	124,567	12.7	3.3	1.1
Sweden (long) United Kingdom (short) ^c	7,644 251,248	43,437	21,161	23,318	783,800	32.1	8.5	2.7
European Free Trade Assoc	32,378	2,468	2,485	5,224	176.587	18.3	4.4	1.4
Norway (short)	11,759	162	2,465	2,177	67,352	22.8	4.4	1.4
Norway (long)	3,620	605	575	NA	01,002	22.0	⊣. ¬	1.0
Switzerland (short)	7,098	245	701	2,232	109,235	15.6	4.3	1.6
Switzerland (long)	9,901	1,456	1,098	815	. 55,255	. 5.5		1.5
Central & Eastern Europe	698,106	158,189	58,879	146,205	4,628,327	15.1	6.6	1.3
Albania	3,963	896	165	535	63,583	6.2	2.3	0.3
Bulgaria	21,951	2,003	478	5,823	120,441	18.2	6.5	0.4
Czech Republic	19,566	2,310	354	5,532	154,028	12.7	5.1	0.2
Hungary (short)	7,725	663	NA	2,161	141,334	16.7	4.7	1.9
Hungary (long)	15,890	1,777	2,731	1,994	•			
Poland	60,224	7,786	4,940	9,680	527,999	11.4	3.3	0.9
Romania	34,240	3,985	287	16,114	374,828	9.1	5.4	0.1
Russia	445,006	127,655	33,236	90,746	2,019,464	22.0	10.8	1.6
Slovak Republic	9,149	1,014	112	3,059	82,430	11.1	4.9	0.1
Turkey	80,392	10,100	16,576	10,561	1,144,220	7.0	1.8	1.4
	4 452 405		lorth Ameri		F 00 / 00 5			
Total	1,451,105	153,106	223,106	111,747	5,921,806	24.5	4.5	3.8
Canada	147,001	14,260	26,067	8,482	381,002	38.6	6.0	6.8
Mexico	129,668	9,381	11,727	39,894	1,964,404	6.6	2.5	0.6
United States	1,174,436	129,465	185,312	63,371	3,576,400	32.8	5.4	5.2

Appendix table 2-1.

Number of first university degrees and percentage of 24-year-olds who earn first university degrees in S&E, by region/country: Most recent year

NA = not available; NS&E = natural sciences and engineering

NOTES: Data are compiled from numerous national and international sources, and degree fields may not be strictly comparable. First university degrees in different countries are of different duration and may not be academically equivalent. In European countries, *short* degree programs are three years long; *long* degree programs take four to six years. U.K. data are for 1996. Data for China, Japan, Singapore, South Korea, Taiwan, Austria, Switzerland, and the United States are for 1995. Data for Finland, France, Germany, Italy, Portugal, Sweden, Norway, Bulgaria, Czech Republic, Russia, Slovak Republic, Canada, and Mexico are for 1994. Data for Hong Kong, Belgium, Denmark, Greece, Ireland, the Netherlands, Spain, Albania, Hungary, Poland, Romania, and Turkey are for 1993. Data for Indonesia and Thailand are for 1992. Indian and Malaysian data are for 1990.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences, as well as mathematics and computer sciences.

^bSocial sciences include psychology, sociology, and other social sciences. Japanese social science data also include business administration. Mexican social science data are estimated.

°U.K. data include former colleges and polytechnics.

SOURCES: ASIA: China - National Research Center for Science and Technology for Development, unpublished tabulations, and UNESCO, Statistical Yearbook (Paris: 1996); Hong Kong – UNESCO (1996); India – Department of Science and Technology, Research and Development Statistics 1994-95 (New Delhi: 1996); Indonesia - UNESCO (1996); Japan - Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); Malaysia - UNESCO (1996); Singapore - National University of Singapore, Annual Report (Singapore: 1996); South Korea - Ministry of Education, Statistical Yearbook of Education (Seoul: 1996); Taiwan - Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996); Thailand - UNESCO (1996); EUROPEAN UNION: Austria - Austrian Central Statistical Office, unpublished tabulations; Belgium - Organisation for Economic Co-operation and Development and Centre for Educational Research and Innovation (OECD/CERI), unpublished tabulations, and UNESCO (1996) (social sciences); Denmark - Department of Higher Education, Ministry of Education, unpublished tabulations (1997); Finland - Central Statistical Office, unpublished tabulations (1997), and OECD/CERI; France - Ministère de l'Éducation Nationale, Repères et Références Statistiques sur les Enseignements et la Formation (Vanves, France: 1996); Germany -Statistisches Bundesamt Wiesbaden, Prüfungen an Hochschulen (Wiesbaden: 1996); Greece - National Statistical Service of Greece, unpublished tabulations (1997), and OECD/CERI; Ireland - OECD/CERI; Italy - Consiglio nazionale delle ricerche, unpublished tabulations (1997); the Netherlands - Department for Statistics of Education and Science, Netherlands Central Bureau of Statistics, unpublished tabulations (1997); Portugal—OECD/CERI; Spain—Estadisticas e Investigaciones Sociales, Instituto National de Estadistica, unpublished tabulations (1997), and OECD/CERI; Sweden - Statistics Sweden, unpublished tabulations (1997), and OECD/CERI; United Kingdom - Higher Education Statistics Agency, Students in Higher Education Institutions: 1995/96 (Cheltenham: 1997); EUROPEAN FREE TRADE ASSOCIATION: Norway - Institute for Studies in Research and Higher Education, the Norwegian Research Council, unpublished tabulations (1997); Switzerland - Swiss Federal Statistical Office, unpublished tabulations (1997); CENTRAL AND EASTERN EUROPE: Albania -UNESCO (1996); Bulgaria – UNESCO (1996); Czech Republic – UNESCO (1996); Hungary – OECD/CERI; Poland – UNESCO (1996); Romania – UNESCO (1996); Rom (1996); Russia – UNESCO (1996); Slovak Republic – UNESCO (1996); Turkey – UNESCO (1996); NORTH AMERICA: Canada – UNESCO (1996) and OECD/ CERI; Mexico - Asociación Nacional de Universidades e Instituciones de Educación Superior, Anuario Estadístico 1995: Posgrado (Mexico: 1996); and United States - National Science Foundation, Science Resources Studies Division, Science and Engineering Degrees 1966-94, NSF 96-321 (Arlington, VA: 1996).

See figures 2-1, 2-2, and 2-4, and text table 2-1.

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Appendix table 2-2. First university degrees in science and engineering awarded in selected Asian countries: 1975-95

	Six-country total	China	Indiaª	Japan	Singapore	South Korea	Taiwan
		All firs	t university de	grees			
975	973,841	NA	NA	313,072	2,380	NA	29,053
976	1,044,332	NA	629,336	326,167	2,388	34,725	29,053
977	1,084,713	NA	651,999	339,819	2,357	37,374	29,685
978	1,051,837	NA	675,478	356,981	2,422	41,447	30,740
979	1,055,792	NA	620,247	374,887	2,763	45,964	32,383
980	989,470	NA	599,795	378,666	2,645	50,973	34,223
981	1,037,879	NA	522,963	386,057	2,187	56,528	32,214
982	1,076,178	NA	560,893	382,466	2,395	62,688	33,341
983	1,112,206	NA	595,288	369,069	2,905	77,272	34,507
984	1,149,352	NA	628,453	372,247	3,725	90,888	35,714
985	1,394,768	183,241	646,778	373,302	4,286	118,584	36,885
986	1,464,453	207,405	678,470	376,260	4,818	137,848	38,567
987	1,526,336	225,312	699,555	382,655	5,119	149,582	38,929
988		249,337	724,739	382,828	5,227	161,983	40,205
989		275,056	740,000	376,688	5,850	166,845	40,856
990	1,638,655	273,684	750,000	400,103	6,000	165,916	42,952
991	1,670,080	262,088	750,000	428,079	6,000	175,586	48,327
992		298,438	750,000	437,878	5,897	178,632	54,375
993	1,820,632	347,068	750,000	445,774	5,796	208,834	63,160
994		310,291	750,000	461,898	5,697	183,372	63,160
995		325,484	750,000	493,277	5,599	184,214	68,274
		Na	atural sciences	S b			
975	107,673	NA	95,382	7,014	466	3,111	1,700
976	110,601	NA	98,038	7,483	490	2,713	1,877
977	113,264	NA	100,768	7,479	335	2,889	1,793
978	117,006	NA	103,574	7,985	347	3,165	1,935
979	113,848	NA	99,724	8,248	528	3,468	1,880
980	116,399	NA	101,455	8,636	573	3,800	1,935
981	118,357	NA	103,217	8,651	460	4,164	1,866
982	120,802	NA	105,008	8,710	577	4,562	1,945
983	123,251	NA	106,831	8,575	663	5,202	1,980
984	126,699	NA	108,686	9,054	726	6,241	1,992
985	148,888	8,686	119,979	9,166	854	8,112	2,091
986	151,327	9,336	122,550	9,435	945	6,913	2,148
987	•	9,115	129,907	9,817	1,012	7,082	2,253
988	•	8,045	130,000	9,895	982	7,673	2,380
989		8,153	134,366	9,900	1,166	8,249	2,428
990	168,941	7,802	139,000	9,866	1,278	8,514	2,481
991	•	6,598	139,000	10,452	1,278	9,703	2,625
992		5,580	139,000	10,386	1,281	11,828	2,777
993		11,087	139,000	10,757	1,283	11,634	2,865
994		36,726	139,000	11,476	1,286	11,443	2,956
995	•	38,029	139,000	12,089	1,289	11,828	3,063

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Appendix table 2-2. First university degrees in science and engineering awarded in selected Asian countries: 1975-95

	Six-country total	China	Indiaª	Japan	Singapore	South Korea	Taiwan
		Mathemati	cs and compute	r sciences			
975	3,690	NA	NA	2,490	NA	NA	1,200
976	4,263	NA	NA	2,529	NA	398	1,336
977	4,506	NA	NA	2,755	NA	464	1,287
978	4,496	NA	NA	2,703	NA	563	1,230
979	4,857	NA	NA	2,829	NA	683	1,345
980	5,168	NA	NA	2,918	NA	828	1,422
981	5,595	NA	NA	3,152	NA	1,005	1,438
982	5,974	NA	NA	3,045	NA	1,393	1,536
983	6,447	NA	NA	3,148	NA	1,589	1,710
984	6,808	NA	NA	3,180	NA	1,918	1,710
985	16,100	7,764	NA	3,532	NA	2,888	1,916
986	· ·	8,604	NA	3,379	NA	2,839	2,134
987	· ·	8,974	NA	3,572	NA	3,149	2,082
988	,	11,115	NA	3,493	NA	5,824	2,414
989	· ·	13,079	NA	3,395	NA	6,274	2,621
990	26,456	13,408	NA	3,554	NA	6,676	2,818
991	28,239	13,847	NA	3,765	NA	7,547	3,080
992	,	14,301	NA	3,790	NA	8,229	3,366
993		12,520	NA	4,221	NA	8,502	3,854
994	· ·	NA	NA	4,574	NA	8,784	4,412
995	•	NA	NA	4,884	NA	12.351	4,832
	,		Agriculture	.,,		,	.,
975	16,792	NA	3,966	9,480	NA	2,546	800
976	· ·	NA	4,623	9,965	NA	2,680	898
977	· ·	NA	5,388	10,455	NA	2,822	866
978	· ·	NA	6,280	10,937	NA	2,971	961
979	· ·	NA	6,280	12,794	NA	3,128	926
980	·	NA	6,599	11,182	NA	3,293	977
981	· ·	NA	6,934	11,555	NA	3,837	1,037
982	•	NA	7,286	11,016	NA	4,493	1,010
983		NA	7,656	10,658	NA NA	4,603	984
984	· ·	NA	8,045	11,189	NA NA	4,327	959
	•		•	-		•	
985 986		11,907	8,257	10,928	NA	4,068	980
	,	13,394	7,414	10,991	NA	5,483	969
987	,	13,850	7,810	11,266	NA	6,395	1,137
988	42,272	14,615	7,827	10,584	NA	8,050	1,196
989	,	14,531	8,301	10,252	NA	8,027	1,133
990	•	15,014	8,000	11,733	NA	8,005	1,234
991	,	14,542	8,000	12,282	NA	6,586	1,272
992	42,413	14,085	8,000	12,284	NA	6,628	1,311
993	47,459	16,994	8,000	13,021	NA	7,843	1,561
994	48,006	15,445	8,000	13,361	NA	9,281	1,859
995	49,398	16,365	8,000	14,970	NA	7,767	2,236

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Appendix table 2-2. First university degrees in science and engineering awarded in selected Asian countries: 1975-95

	Six-country total	China	Indiaª	Japan	Singapore	South Korea	Taiwan
		;	Social sciences	С			
1975	137,245	NA	NA	134,645	NA		2,600
1976	143,443	NA	NA	139,258	NA	1,423	2,762
1977	147,682	NA	NA	143,416	NA	1,379	2,887
1978	155,854	NA	NA	151,519	NA	1,452	2,883
1979	162,506	NA	NA	158,023	NA	1,528	2,955
1980	162,909	NA	NA	158,394	NA	1,609	2,906
1981	•	NA	NA	160,520	NA	1,694	2,889
1982	•	NA	NA	159,450	NA	1,783	3,053
1983	•	NA	NA	151,996	NA	4,297	3,034
1984	•	NA	NA	151,626	90	3,297	3,134
1985	,	13,855	NA	151,072	86	6,472	3,265
1986	•	16,515	NA	151,056	91	7,670	3,109
1987	•	19,619	NA	150,956	106	8,867	3,297
1988	•	22,707	NA NA	150,819	106	9,619	3,327
1989	•	27,713	NA NA	147,087	102	8,098	3,159
1990	,	28,728	NA	157,477	117	10,211	3,174
1991	•	•				•	-
1992	,	32,163	NA NA	170,721	117	18,483	3,737
	/	36,009	NA	177,240	232	18,251	4,399
1993	•	31,656	NA	179,338	461	17,808	4,487
1994	,	29,622	NA	186,586	916	17,376	4,577
1995	256,573	32,075	NA .	200,875	1,820	16,955	4,848
			Engineering				
1975	,	NA	14,073	66,512	236	7,155	5,000
1976	95,838	NA	15,057	68,126	241	7,272	5,142
1977	99,947	NA	16,110	70,431	290	7,858	5,258
1978	104,421	NA	17,237	72,466	240	8,919	5,559
1979	109,356	NA	17,236	75,409	272	10,124	6,315
1980	111,080	NA	18,100	74,737	288	11,492	6,463
1981	116,043	NA	19,007	76,370	323	13,044	7,299
1982	117,198	NA	19,959	74,774	349	14,806	7,309
1983	120,324	NA	20,960	70,824	585	20,636	7,320
1984	123,755	NA	22,010	71,640	585	22,190	7,330
1985	198,734	73,075	21,088	72,560	769	23,539	7,703
1986	214,434	79,556	24,096	74,516	924	27,612	7,730
1987	227,315	87,166	27,057	77,077	907	27,600	7,508
1988	•	101,411	27,000	77,503	1,001	26,891	7,994
1989		112,108	28,927	77,009	1,105	28,141	8,007
1990	257,325	108,729	29,000	81,355	1,220	28,071	8,950
1991		114,620	29,000	87,397	1,347	30,692	9,239
1992		120,830	29,000	88,385	1,423	31,800	9,537
1993	,	120,831	29,000	88,406	1,503	33,043	10,293
1994		141,654	29,000	91,184	1,587	34,334	11,108
1995	•					*	
1990	324,468	148,844	29,000	97,392	1,676	35,449	12,107

NA = not available

SOURCES: **China**—National Research Center for Science and Technology for Development, unpublished tabulations; **India**—Department of Science and Technology, *Research and Development Statistics 1994-95* (New Delhi:1996); **Japan**—Ministry of Education, Science, and Culture (Monbusho), *Monbusho Survey of Education* (Tokyo: annual series); **Singapore**—National University of Singapore, *Annual Report* (Singapore: 1996); **South Korea**—Ministry of Education, *Statistical Yearbook of Education* (Seoul: 1996), Organisation for Economic Co-operation and Development and Centre for Educational Research and Innovation, unpublished tabulations, and UNESCO (1996); and **Taiwan**—Ministry of Education, *Educational Statistics of the Republic of China* (Taipei: 1996).

^aIndian data are estimated for 1990-95.

^bNatural sciences here include physical, earth, atmospheric, oceanographic, and biological sciences.

^cSocial sciences include psychology, sociology, and other social sciences. Japanese social science data also include business administration.

Appendix table 2-3. **Population of 20- to 24-year-olds in selected countries/regions: 1975-2010** (Thousands)

	Olitera	L. P.	Western	United	
	China	India	Europe	States	Japan
1975	89,178	52,885	25,819	19,527	9,189
1976	88,370	54,634	26,075	19,922	8,916
1977	87,569	56,441	26,336	20,244	8,652
1978	86,776	58,308	26,602	20,505	8,395
1979	85,990	60,237	26,872	20,716	8,146
1980	85,211	62,229	27,146	21,584	7,904
1981	89,116	63,681	27,628	21,508	7,959
1982	93,201	65,167	28,121	21,433	8,015
1983	97,472	66,688	28,626	21,358	8,071
1984	101,940	68,244	29,143	21,283	8,127
1985	106,612	69,837	29,672	21,208	8,184
1986	110,434	71,349	29,575	20,700	8,329
1987	114,392	72,893	29,482	20,205	8,477
1988	118,493	74,470	29,391	19,721	8,628
1989	122,740	76,082	29,302	19,249	8,781
1990	127,140	77,729	29,356	18,788	8,937
1991	126,109	79,529	28,732	18,780	9,137
1992	125,086	81,372	28,096	18,771	9,342
1993	124,072	83,256	27,504	18,762	9,551
1994	123,066	85,185	26,937	17,853	9,765
1995	122,068	87,158	26,393	17,626	9,984
1996	116,094	87,594	25,824	17,501	9,664
1997	110,412	88,033	25,255	17,377	9,354
1998	105,008	88,473	24,686	17,254	9,054
1999	99,869	88,916	24,117	17,131	8,763
2000	94,981	89,361	23,548	17,010	8,482
2001	94,112	92,010	23,324	18,068	8,255
2002	93,251	94,738	23,100	18,292	8,035
2003	92,398	97,546	22,876	18,515	7,820
2004	91,553	100,438	22,652	18,739	7,611
2005	90,715	103,415	22,428	18,962	7,408
2006	95,379	104,983	25,482	19,038	7,282
2007	100,284	106,575	28,535	19,113	7,158
2008	105,440	108,190	31,589	19,189	7,036
2009	110,862	109,831	34,642	19,264	6,917
2010	116,562	111,496	37,696	19,340	6,799

SOURCES: U.S. Bureau of the Census, *Current Population Reports*, series P-25, Nos. 519 and 917; and World Bank, Population and Human Resources Department, *Population Projections*, 1992-1993 Edition (Washington, DC).

See figure 2-3.

Appendix table 2-4.

Percentage of 24-year-olds who earn first university degrees in S&E, by sex and region/country: Most recent year

			Degree field	s		24-year	-olds	
Region/country	All first university degrees	Natural sciences ^a	Social sciences ^b	Engineering	Total number	% with first univ. degree	% with NS&E degree	% with soc. sci
			Males					
Naia			Iviales					
Asia	004.007	00.500	400 547	04.070	4 000 000	00.7		40.0
Japan	334,227	22,536	163,517	91,078	1,023,200	32.7	11.1	16.0
South Korea	107,898	18,676	11,667	32,947	462,200	23.3	11.2	2.5
āiwan	37,647	7,156	2,038	11,317	179,200	21.0	10.3	1.1
European Union								
Austria	6,530	1,189	370	1,069	57,775	11.3	3.9	0.6
Denmark	10,364	1,427	665	876	38,306	27.1	6.0	1.7
inland	7,203	1,511	292	3,067	32,306	22.3	14.2	0.9
rance	57,156	NA	NA	15,319	437,799	13.1	NA	NA
				•	,			3.7
Germany	114,953	19,247	25,314	34,628	693,431	16.6	7.8	
Greece	7,718	1,492	71	1,352	77,784	9.9	3.7	9.1
reland	6,712	1,347	433	1,339	33,135	20.3	8.1	1.3
taly	47,863	6,662	3,944	8,075	457,580	10.5	3.2	0.9
he Netherlands	35,933	4,458	6,610	8,081	115,962	31.0	10.8	5.7
Portugal	8,538	748	902	1,804	83,440	10.2	3.1	1.1
Spain	60,521	8,026	1,688	9,016	338.120	17.9	5.0	0.5
Sweden	7,017	1,032	315	1,946	64,147	10.9	4.6	0.5
			9,417				11.2	2.3
Jnited Kingdom ^c	122,767	24,920	9,417	19,844	401,200	30.6	11.2	2.3
European Free Trade Association								
Norway	5,919	450	297	1,786	33,552	17.6	6.7	0.9
Switzerland	5,931	1,116	427	736	54,916	10.8	3.4	0.8
Central & Eastern Europe								
Czech Republic	10,054	1,501	1,196	4,244	80,019	12.6	7.2	1.5
lungary	10,650	1,674	1,038	3,365	72,903	14.6	6.9	1.4
Poland	29,067	3,772	1,968	8,299	271,111	10.7	4.5	0.7
		5,227						
urkey	45,557	5,227	8,140	8,010	583,346	7.8	2.3	1.4
North America								
Canada	52,728	7,625	9,835	6,616	193,759	27.2	7.3	5.1
Jnited States	531,146	73,540	52,421	67,125	1,815,831	29.3	6.9	4.2
			Females					
Asia								
Japan	159,050	8,043	37,358	3,358	973,600	16.3	1.2	3.8
South Korea	66,088	11,229	4,100	6,314	428,600	15.4	4.1	1.0
Taiwan	30,627	2,975	2,810	790	169,200	18.1	2.2	1.7
	30,027	2,973	2,010	790	109,200	10.1	2.2	1.7
European Union	F 000	500	500	77	55.400	0.4	4.0	4.0
Austria	5,200	566	529	77	55,160	9.4	1.2	1.0
Denmark	13,042	2,714	871	237	36,992	35.3	8.0	2.4
Finland	6,919	636	515	477	30,868	22.4	3.6	1.7
rance	63,086	NA	NA	3,994	418,116	15.1	NA	NA
Germany	82,120	10,261	20,949	3,989	661,435	12.4	2.2	3.2
Greece	10,838	1,078	150	433	74,038	14.6	2.0	0.2
reland	7,392	1,188	743	210	31,250	23.7	4.5	2.4
			6,481					
taly	55,262	6,423		941	439,668	12.6	1.7	1.5
The Netherlands	33,235	1,427	7,653	1,422	112,539	29.5	2.5	6.8
Portugal	13,964	1,011	1,744	664	80,759	17.3	2.1	2.2
Spain	77,302	5,778	4,026	1,801	321,199	24.1	2.4	1.3
Sweden	8,753	620	997	558	60,420	14.5	1.9	1.7
Jnited Kingdom ^c	128,481	18,517	11,744	3,474	382,600	33.6	5.7	3.1
European Free Trade Association	-, -= -	- /	,	-,	,			
	13,104	175	168	466	33,800	38.8	1.9	0.5
lorway								
Switzerland	3,272	376	495	26	54,319	6.0	0.7	0.9
Central & Eastern Europe								
Czech Republic	9,512	852	1,845	1,316	74,009	12.9	2.9	2.5
Hungary	12,965	766	1,693	790	68,431	18.9	2.3	2.5
Poland	31,157	4,014	2,972	1,381	256,888	12.1	2.1	1.2
Turkey	27,025	4,007	4,374	2,063	560,849	4.8	1.1	0.8
North America	21,020	.,007	1,014	_,000	555,545	7.0		0.0
	70,474	E E00	14 740	1 100	107 040	97 E	2.6	7.0
	/114/4	5,533	14,742	1,122	187,243	37.6	3.6	7.9
Danada	643,290	55,925	109,056	10,950	1,750,926	36.7	3.8	6.2

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Appendix table 2-4.

Percentage of 24-year-olds who earn first university degrees in S&E, by sex and region/country: Most recent year

NA = not available; NS&E = natural sciences and engineering

NOTES: Data from European countries combine short (three-year) and long (four- to six-year) degree programs. Data are compiled from numerous national and international sources, and degree fields may not be strictly comparable. First university degrees in different countries are of different duration and may not be academically equivalent. U.K. data are for 1996. Data for Japan, South Korea, Taiwan, Austria, Switzerland, and the United States are for 1995. Data for Finland, France, Germany, Italy, Portugal, Sweden, Norway, Czech Republic, and Canada are for 1994. Data for Denmark, Greece, Ireland, the Netherlands, Spain, Hungary, Poland, and Turkey are for 1993.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural, as well as mathematics and computer sciences.

^bSocial sciences include psychology, sociology, and other social sciences. Japanese social science data also include business administration.

^cU.K. data include former colleges and polytechnics.

SOURCES: ASIA: Japan—Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); South Korea—Ministry of Education, Statistical Yearbook of Education (Seoul: 1996); Taiwan—Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996); EUROPEAN UNION: Austria—Austrian Central Statistical Office, unpublished tabulations; Denmark—Department of Higher Education, Ministry of Education, unpublished tabulations (1997); Finland—Central Statistical Office, unpublished tabulations (1997), and Organisation for Economic Co-operation and Development and Centre for Educational Research and Innovation (OECD/CERI), unpublished tabulations; France—Ministère de l'Éducation Nationale, Repères et Références Statistiques sur les Enseignements et la Formation (Vanves, France: 1996); Germany—Statistisches Bundesamt Wiesbaden, Prüfungen an Hochschulen (Wiesbaden: 1996); Greece—National Statistical Service of Greece, unpublished tabulations (1997), and OECD/CERI; Ireland—OECD/CERI; Italy—Consiglio nazionale delle ricerche, unpublished tabulations (1997); the Netherlands—Department for Statistics of Education and Science, Netherlands Central Bureau of Statistics, unpublished tabulations (1997); Portugal—OECD/CERI; Spain—Estadisticas e Investigaciones Sociales, Instituto National de Estadistica, unpublished tabulations (1997), and OECD/CERI; United Kingdom—Higher Education Statistics Agency, Students in Higher Education Institutions: 1995/96 (Cheltenham: 1997); EUROPEAN FREE TRADE ASSOCIATION: Norway—Institute for Studies in Research and Higher Education, the Norwegian Research Council, unpublished tabulations (1997); Stephand—Swiss Federal Statistical Office, unpublished tabulations (1997); CENTRAL AND EASTERN EUROPE: Czech Republic—UNESCO (1996); Hungary—OECD/CERI; Poland—UNESCO (1996); Turkey—UNESCO (1996); NORTH AMERICA: Canada—UNESCO (1996) and OECD/CERI; and United States—National Science Foundation, Science Resources Studies Division, Science and Engineering

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Appendix table 2-5. Share of first university S&E degrees, by sex and country: Most recent year (Percentages)

Region/country	Natural sciences ^a	Math & comp. sciences	Agricultural sciences	Social sciences ^b	Engineering
		Males			
Asia					
Japan	79	77	68	81	94
South Korea	56	60	63	73	93
Taiwan	73	71	66	42	93
European Union					
Austria	63	78	60	41	94
Denmark	69	16	67	43	79
Finland	49	87	63	36	87
France	NA	63	NA	NA	80
Germany	64	69	60	55	90
Greece	57	58	62	32	76
Ireland	46	63	68	37	86
Italy	46	51	66	38	90
The Netherlands	66	11	77	46	85
Portugal	36	45	47	34	73
Spain	53	67	52	30	83
Sweden	47	77	50	24	78
United Kingdom ^c	50	73	49	46	85
European Free Trade Assoc.					
Norway	54	84	78	43	82
Switzerland	72	88	63	40	93
Central & Eastern Europe	. –				
Czech Republic	47	77	64	39	76
Hungary	66		69	38	81
Poland	33	32	62	40	86
Turkey	50	53	65	65	80
North America	00	00	00	00	00
Canada	52	70	47	40	86
United States	53	65	65	45	85
Office Otales		Females			
A - * -		Tomaioo			
Asia	0.4	00	00	40	0
Japan	21	23	32	19	6
South Korea	44	40	37	27	7
Taiwan	27	29	34	58	7
European Union				=-	_
Austria	37	22	40	59	6
Denmark	31	84	33	57	21
Finland	51	13	37	64	13
France	NA	37	NA	NA	20
Germany	36	31	40	45	10
Greece	43	42	38	68	24
Ireland	54	37	32	63	14
Italy	54	49	34	62	10
The Netherlands	34	89	23	54	15
Portugal	64	55	53	66	27
Spain	47	33	48	70	17
Sweden	53	23	50	76	22
United Kingdom ^c	50	27	51	55	15
European Free Trade Assoc.					
Norway	46	16	22	57	18
Switzerland	28	12	37	60	7
Central & Eastern Europe					
Czech Republic	53	23	36	61	24
Hungary	34		31	62	19
Poland	67	68	38	60	14
Turkey	50	47	35	35	20
North America					
Canada	48	30	53	60	14
United States	47	35	35	55	15

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Appendix table 2-5. **Share of first university S&E degrees, by sex and country: Most recent year** (Percentages)

NA = not available

NOTES: Data from European countries combine short (three-year) and long (four- to six-year) degree programs. Data are compiled from numerous national and international sources, and degree fields may not be strictly comparable. First university degrees in different countries are of different duration and may not be academically equivalent. U.K. data are for 1996. Data for Japan, South Korea, Taiwan, Austria, Switzerland, and the United States are for 1995. Data for Finland, France, Germany, Italy, Portugal, Sweden, Norway, Czech Republic, and Canada are for 1994. Data for Denmark, Greece, Ireland, the Netherlands, Spain, Hungary, Poland, and Turkey are for 1993.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, and biological sciences.

^bSocial sciences include psychology, sociology, and other social sciences. Japanese social science data also include business administration.

°U.K. data include former colleges and polytechnics.

SOURCES: ASIA: Japan - Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); South Korea-Ministry of Education, Statistical Yearbook of Education (Seoul: 1996); Taiwan-Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996); EUROPEAN UNION: Austria - Austria Central Statistical Office, unpublished tabulations: **Denmark**—Department of Higher Education, Ministry of Education, unpublished tabulations (1997); Finland - Central Statistical Office, unpublished tabulations (1997), and Organisation for Economic Cooperation and Development and Centre for Educational Research and Innovation (OECD/CERI), unpublished tabluations; France – Ministère de l'Éducation Nationale, Repères et Références Statistiques sur les Enseignements et la Formation (Vanves, France: 1996); Germany - Statistisches Bundesamt Wiesbaden, Prüfungen an Hochschulen (Wiesbaden: 1996); Greece-National Statistical Service of Greece, unpublished tabulations (1997), and OECD/CERI; Ireland—OECD/CERI; Italy—Consiglio nazionale delle ricerche, unpublished tabulations (1997); the Netherlands - Department for Statistics of Education and Science, Netherlands Central Bureau of Statistics, unpublished tabulations (1997); Portugal—OECD/CERI; Spain—Estadisticas e Investigaciones Sociales, Instituto National de Estadistica, unpublished tabulations (1997) and OECD/CERI; Sweden - Statistics Sweden, unpublished tabulations (1997), and OECD/CERI; United Kingdom - Higher Education Statistics Agency, Students in Higher Education Institutions: 1995/96 (Cheltenham: 1997); EUROPEAN FREE TRADE ASSOCIATION: Norway-Institute for Studies in Research and Higher Education, the Norwegian Research Council, unpublished tabulations (1997); Switzerland-Swiss Federal Statistical Office, unpublished tabulations (1997); CENTRAL AND EASTERN EUROPE: Czech Republic-UNESCO (1996); Hungary—OECD/CERI; Poland—UNESCO (1996); Turkey—UNESCO (1996); NORTH AMERICA: Canada— UNESCO (1996) and OECD/CERI; and United States - National Science Foundation, Science Resources Studies Division, Science and Engineering Degrees 1966-94, NSF 96-321 (Arlington, VA: 1996).

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Appendix table 2-6. **Proportion of first university degrees awarded in S&E, by region/country: Most recent year** (Percentages)

				Degree	fields	
	Total first	Total	Natural	Social		
Region/country	univ. degrees	S&E	sciences ^a	sciences ^b	Engineering	Non-S&E
		Asi	a			
China	100	72	17	10	46	28
Hong Kong	100	48	21	11	16	52
India	100	23	20	NA	4	77
Indonesia	100	44	14	18	12	56
Japan	100	67	6	41	20	33
Malaysia	100	45	16	21	8	55
Singapore	100	100	38	33	30	0
South Korea	100	46	17	9	19	54
Taiwan	100	40	15	7	18	60
Fhailand	100	21	9	6	6	79
illalialiu	100	Euro		0	0	13
European Union		Luit	, p c			
European Onion Austria	100	34	16	8	10	66
Belgium	100	57	9	26	22	43
•	100	29	9 7	7	15	71
Denmark						
Finland	100	46	15	6	25	54
rance	100	32	16	NA	16	68
Germany	100	46	16	9	21	54
Greece	100	25	14	1	10	75
reland	100	37	18	8	11	63
taly	100	32	13	10	9	68
The Netherlands	100	39	7	17	15	61
Portugal	100	31	8	12	11	69
Spain	100	26	14	7	5	74
Sweden	100	35	10	8	16	65
Jnited Kingdom ^c	100	35	17	8	9	65
European Free Trade Association						
Norway	100	24	5	4	14	76
Switzerland	100	39	10	11	18	61
Central & Eastern Europe						
Albania	100	40	23	4	13	60
Bulgaria	100	38	9	2	27	62
Czech Republic	100	42	12	2	28	58
Hungary	100	39	10	12	18	61
Poland	100	37	13	8	16	63
Romania	100	60	12	1	47	40
Russia	100	57	29	7	20	43
	100	46	11	1	33	54
Slovak Republic	100	46 46	13	21	33 13	54 54
Turkey	100	North A		21	10	J4
	100			10	6	67
Canada	100	33	10	18	6	67 50
Mexico	100	47	7	9	31	53
United States	100	32	10	16	5	68

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Appendix table 2-6.

Proportion of first university degrees awarded in S&E, by region/country: Most recent year (Percentages)

NA = not available

NOTES: Data from European countries combine short (three-year) and long (four- to six-year) degree programs. Data are compiled from numerous national and international sources, and degree fields may not be strictly comparable. U.K. data are for 1996. Data for China, Japan, Singapore, South Korea, Taiwan, Austria, Switzerland, and the United States are for 1995. Data for Finland, France, Germany, Italy, Portugal, Sweden, Norway, Bulgaria, Czech Republic, Russia, Slovakia, Canada, and Mexico are for 1994. Data for Hong Kong, Belgium, Denmark, Greece, Ireland, the Netherlands, Spain, Albania, Hungary, Poland, Romania, and Turkey are for 1993. Data for Indonesia and Thailand are for 1992. Indian and Malaysian data are for 1990.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural, as well as mathematics and computer sciences.

^bSocial sciences include psychology, sociology, and other social sciences. Japanese social science data also include business administration. Mexican social science data are estimated.

^cU.K. data include former colleges and polytechnics.

SOURCES: ASIA: China - National Research Center for Science and Technology for Development, unpublished tabulations, and UNESCO, Statistical Yearbook (Paris: 1996); Hong Kong – UNESCO (1996); India – Department of Science and Technology, Research and Development Statistics 1994-95 (New Delhi: 1996); Indonesia - UNESCO (1996); Japan - Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); Malaysia – UNESCO (1996); Singapore – National University of Singapore, Annual Report (Singapore: 1996); South Korea – Ministry of Education, Statistical Yearbook of Education, 1996 (Seoul: 1996); Taiwan - Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996); Thailand - UNESCO (1996); EUROPEAN UNION: Austria - Austrian Central Statistical Office, unpublished tabulations; Belgium - Organisation for Economic Co-operation and Development and Centre for Educational Research and Innovation (OECD/CERI), unpublished tabulations, and UNESCO (1996) (social sciences); Denmark-Department of Higher Education, Ministry of Education, unpublished tabulations (1997); Finland—Central Statistical Office, unpublished tabulations (1997), and OECD/CERI; France - Ministère de l'Éducation Nationale, Repères et Références Statistiques sur les Enseignements et la Formation (Vanves, France: 1996); Germany - Statistisches Bundesamt Wiesbaden, Prüfungen an Hochschulen (Wiesbaden: 1996); Greece - National Statistical Service of Greece, unpublished tabulations (1997), and OECD/CERI; Ireland—OECD/CERI; Italy—Consiglio nazionale delle ricerche, unpublished tabulations (1997); the Netherlands— Department for Statistics of Education and Science, Netherlands Central Bureau of Statistics, unpublished tabulations (1997); Portugal — OECD/CERI; Spain — Estadisticas e Investigaciones Sociales, Instituto National de Estadistica, unpublished tabulations (1997) and OECD/CERI; Sweden - Statistics Sweden, unpublished tabulations (1997), and OECD/CERI; United Kingdom - Higher Education Statistics Agency, Students in Higher Education Institutions: 1995/96 (Cheltenham: 1997); EUROPEAN FREE TRADE ASSOCIATION: Norway-Institute for Studies in Research and Higher Education, the Norwegian Research Council, unpublished tabulations (1997); Switzerland - Swiss Federal Statistical Office, unpublished tabulations (1997); CENTRAL AND EASTERN EUROPE: Albania - UNESCO (1996); Bulgaria - UNESCO (1996); Czech Republic - UNESCO (1996); Hungary - OECD/CERI; Poland - UNESCO (1996); Romania -UNESCO (1996); Russia - UNESCO (1996); Slovak Republic - UNESCO (1996); Turkey - UNESCO (1996); NORTH AMERICA: Canada - UNESCO (1996) and OECD/CERI; Mexico - Asociación Nacional de Universidades e Instituciones de Educación Superior, Anuario Estadístico 1995: Posgrado (Mexico: 1996); and United States - National Science Foundation, Science Resources Studies Division, Science and Engineering Degrees 1966-94, NSF 96-321 (Arlington, VA: 1996).

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Appendix table 2-7. **Proportion of first university degrees awarded in S&E, by sex and region/country: Most recent year** (Percentages)

				Degree	fields	
Region/country	Total first univ. degrees	Total S&E	Natural sciences ^a	Social sciences ^b	Engineering	Non-S&E
		Mal	es			
Asia						
lapan	100	83	7	49	27	17
South Korea	100	59	17	11	31	41
Taiwan	100	54	19	5	30	46
European Union	100	34	13	3	30	40
-	100	40	10	6	16	60
Austria	100	40	18	6	16	60
Denmark	100	29	14	6	8	71
Finland	100	68	21	4	43	32
Germany	100	69	17	22	30	31
Greece	100	38	19	1	18	62
reland	100	46	20	6	20	54
taly	100	39	14	8	17	61
The Netherlands	100	53	12	18	22	47
Portugal	100	40	9	11	21	60
Spain	100	31	13	3	15	69
Sweden	100	47	15	4	28	53
Jnited Kingdom ^c	100	44	20	8	16	56
European Free Trade Association						
Norway	100	43	8	5	30	57
Switzerland	100	38	19	7	12	62
Central & Eastern Europe						
Czech Republic	100	69	15	12	42	31
Hungary	100	57	16	10	32	43
Poland	100	48	13	7	29	52
Turkey	100	47	11	18	18	53
	100	41	11	10	10	33
North America	100	40	4.4	10	10	T 4
Canada	100	46	14	19	13	54
United States	100	43	13	17	12	57
		Fema	ales			
Asia			_		_	
Japan	100	31	5	23	2	69
South Korea	100	33	17	6	10	67
Taiwan	100	21	10	9	3	79
European Union						
Austria	100	23	11	10	1	77
Denmark	100	29	21	7	2	71
Finland	100	24	9	7	7	76
_	100	43	12	26	5	57
Germany					5 4	
Greece	100	15	10	1	•	85
reland	100	29	16	10	3	71
taly	100	25	12	12	2	75
The Netherlands	100	32	4	23	4	68
Portugal	100	24	7	12	5	76
Spain	100	15	7	5	2	85
Sweden	100	25	7	11	6	75
Jnited Kingdom ^c	100	26	14	9	3	74
European Free Trade Association	100	20	17	3	J	7 -
	100	6	1	1	4	94
Norway						
Switzerland	100	27	11	15	1	73
Central & Eastern Europe	100	46	ā			
Czech Republic	100	42	9	19	14	58
Hungary	100	25	6	13	6	75
Poland	100	27	13	10	4	73
Turkey	100	39	15	16	8	61
North America						
Canada	100	43	13	17	12	57
		. •		18	· -	73

Appendix table 2-7.

Proportion of first university degrees awarded in S&E, by sex and region/country: Most recent year (Percentages)

NA = not available

NOTES: Data from European countries combine short (three-year) and long (four- to six-year) degree programs. Data are compiled from numerous national and international sources, and degree fields may not be strictly comparable. U.K. data are for 1996. Data for Japan, South Korea, Taiwan, Austria, Switzerland, and the United States are for 1995. Data for Finland, Germany, Italy, Portugal, Sweden, Norway, Czech Republic, and Canada are for 1994. Data for Denmark, Greece, Ireland, the Netherlands, Spain, Hungary, Poland, and Turkey are for 1993.

^aNatural sciences here include physical,earth, atmospheric, oceanographic, biological, and agricultural, as well as mathematics and computer sciences.

bSocial sciences include psychology, sociology, and other social sciences. Japanese social science data also include business administration.

°U.K. data include former colleges and polytechnics.

SOURCES: ASIA: Japan—Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); South Korea—Ministry of Education, Statistical Yearbook of Education (Seoul: 1996); Taiwan—Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996); EUROPEAN UNION: Austria—Austrian Central Statistical Office, unpublished tabulations; Denmark—Department of Higher Education, Ministry of Education, unpublished tabulations (1997); Finland—Central Statistical Office, unpublished tabulations (1997), and Organisation for Economic Co-operation and Development and Centre for Educational Research and Innovation (OECD/CERI); Germany—Statistisches Bundesamt Wiesbaden, Prüfungen an Hochschulen (Wiesbaden: 1996); Greece—National Statistical Service of Greece, unpublished tabulations (1997), and OECD/CERI; Ireland—OECD/CERI; Italy—Consiglio nazionale delle ricerche, unpublished tabulations (1997); the Netherlands—Department for Statistics of Education and Science, Netherlands Central Bureau of Statistics, unpublished tabulations (1997); Portugal—OECD/CERI; Spain—Estadisticas e Investigaciones Sociales, Instituto National de Estadistica, unpublished tabulations (1997) and OECD/CERI; Sweden—Statistics Sweden, unpublished tabulations (1997), and OECD/CERI; United Kingdom—Higher Education Statistics Agency, Students in Higher Education Institutions: 1995/96 (Cheltenham: 1997); EUROPEAN FREE TRADE ASSOCIATION: Norway—Institute for Studies in Research Higher Education, the Norwegian Research Council, unpublished tabulations (1997); Switzerland—Swiss Federal Statistical Office, unpublished tabulations (1997); Switzerland—Swiss Federal Statistical Office, Statistical Yearbook (Paris: 1996); Turkey—UNESCO (1996); NORTH AMERICA: Canada—UNESCO (1996) and OECD/CERI; poland—UNESCO, Statistical Yearbook (Paris: 1996); Turkey—UNESCO (1996); North America: Canada—UNESCO (1996) and OECD/CERI; and United States—National Science Foundation, Science Resources Studies Division, Science and

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Appendix table 2-8. Enrollment in higher education, by Carnegie institution type: 1967-94

	Total	Research I	Research	Doctorate- granting I	Doctorate- granting II	Compre- hensive I	Compre- hensive II	Liberal arts I	Liberal arts II	Two- year	Specialized	Other	Not classified
1967 1968 1969 1970 1971	6,963,687 7,571,636 8,066,233 8,649,368 9,025,031 9,297,787	1,510,037 1,564,981 1,644,645 1,748,776 1,717,735 1,768,282	494,527 517,844 538,934 570,365 577,538 581,139	437,195 455,455 483,378 509,450 519,572 521,856	354,542 389,249 410,395 436,660 457,251 466,371	1,661,186 1,813,749 1,935,316 2,071,472 2,160,655 2,183,621	109,412 119,881 127,467 137,127 143,124	203,663 209,398 215,618 221,996 228,947 233,939	411,819 431,621 443,108 452,087 464,590	1,426,223 1,709,796 1,912,663 2,180,252 2,435,108 2,609,721	179,824 187,216 196,120 209,689 219,362 229,938	26,108 27,560 29,914 32,862 35,281 31,451	149,151 144,886 128,675 78,632 65,868 64,981
1973 1974 1975 1976	9,694,297 10,321,539 11,290,719 11,121,426	1,771,632 1,826,768 1,921,415 1,893,269	592,051 612,510 642,703 613,142	526,349 545,772 560,827 568,570	479,905 497,963 532,135 526,247	2,249,865 2,324,124 2,464,953 2,415,834	141,812 153,182 163,672 168,445	236,910 238,868 240,097 240,730	477,097 494,426 541,017 551,890	2,872,230 3,272,215 3,837,843 3,755,311	250,810 271,148 304,401 307,760	36,007 34,553 35,149 33,066	59,629 50,010 46,507 47,162
1977 1978 1979 1980 1981 1983 1984	11,418,631 11,393,015 11,707,126 12,234,644 12,517,753 12,588,520 12,633,930 12,400,392 12,411,945	1,877,142 1,864,590 1,903,347 1,947,444 1,961,015 1,933,340 1,957,038 1,952,748 1,959,685 1,989,839	619,941 626,213 639,287 655,874 659,114 650,946 648,369 641,723 653,298	579,896 581,343 594,589 604,769 610,640 606,683 612,818 604,742 603,961	543,360 542,558 547,418 570,666 578,653 582,638 589,126 591,400 589,103	2,474,300 2,452,812 2,462,361 2,531,409 2,564,542 2,570,690 2,592,710 2,576,072 2,589,406 2,629,336	174,612 178,964 183,554 188,971 197,462 200,403 205,689 203,725 208,603 210,267	243,738 251,607 251,231 260,645 257,592 252,029 254,700 253,604 254,972	573,678 579,494 603,830 633,712 644,924 651,192 668,374 656,099 656,146	3,926,266 3,910,980 4,103,418 4,404,276 4,598,599 4,671,136 4,640,343 4,456,709 4,456,709 4,452,391 4,598,068	322,060 334,133 349,810 371,265 382,729 398,091 408,837 410,765 406,794	35,077 34,665 34,984 35,861 37,109 37,800 39,412 38,571 38,467 39,097	48,561 35,656 33,297 29,752 25,374 33,572 16,514 11,901 10,694 25,668
1987 1988 1990 1991 1992 1993 1994	12,925,116 13,205,540 13,621,725 13,871,725 14,527,724 14,657,118 14,449,476 14,432,145	2,013,832 2,029,065 2,046,868 2,078,969 2,094,841 2,089,045 2,078,625 2,078,625 2,079,559 2,079,559	664,997 685,731 704,842 714,180 720,127 714,126 701,058 694,454 691,292	619,854 631,073 644,062 656,807 660,908 655,985 648,068 639,831	601,073 608,663 623,988 634,551 643,519 649,549 644,533 650,816 659,197	2,675,959 2,738,439 2,831,502 2,882,708 2,961,425 2,962,204 2,941,741 2,924,462 2,921,613	219,167 227,937 238,431 243,690 255,272 259,253 261,163 266,854 265,523	262,649 269,151 266,907 268,223 268,960 266,735 264,222 264,737 267,327	665,726 693,086 716,902 730,455 757,093 781,168 791,081 797,088	4,736,425 4,840,892 5,069,469 5,145,123 5,590,543 5,658,832 5,498,797 5,442,459 5,406,744	404,257 422,184 419,901 440,214 454,819 477,202 489,342 496,522 496,508	41,729 39,953 40,260 40,728 44,370 46,560 47,936 48,725 48,725	19,448 19,366 18,071 36,077 75,847 96,459 111,229 143,969 147,300

SOURCES: National Center for Education Statistics, Enrollment Survey (Mashington, DC: 1995); and National Science Foundation, Science Resources Studies Division, unpublished tabulations.

Science & Engineering Indicators – 1998

See figures 2-5 and 2-6.

Appendix table 2-9. Number of science and engineering degrees, by degree level and institution type: 1995

Institution type	Total degrees	Total S&E	Natural sciences ^a	Math & computer sciences	Social sciences ^b	Engineering	Engineering technology
		В	achelor's degre	es			
Total	1,174,436	378,148	90,845	38,620	185,312	63,371	16,607
Research I	277,600	125,652	31,638	8,006	55,994	30,014	1,631
Research II	94,638	34,672	8,116	2,236	16,155	8,165	1,194
Doctorate-granting I	81,634	23,697	4,865	2,433	12,513	3,886	1,128
Doctorate-granting II	78,568	27,154	5,319	2,836	12,224	6,775	1,044
Comprehensive I	386,961	100,486	23,782	13,633	53,236	9,835	6,347
Comprehensive II	36,300	8,196	1,886	1,364	4,635	311	708
Liberal arts I	52,036	25,523	7,758	1,738	15,567	460	0
Liberal arts II	114,318	25,156	6,501	4,171	13,474	1,010	1,778
Two-year	1,707	146	50	20	56	20	447
Specialized	43,892	4,779	593	2,008	308	1,870	2,211
Other	4,858	2,477	328	157	967	1,025	17
Not classified	1,924	210	9	18	183	0	102
Not classified	1,924		์ Master's degree		165	0	102
Total	399,428	94.309	14,793	14,495	36,391	28.630	1,577
Research I	122,809	39,502	7,206	5,054	11,916	15,326	382
	•	,	,	,	,	,	ა₀∠ 34
Research II	33,115	10,916	1,799	1,359	3,556	4,202	~ .
Doctorate-granting I	39,557	9,025	1,192	1,896	3,691	2,246	169
Doctorate-granting II	30,319	8,726	1,416	1,640	2,902	2,768	102
Comprehensive I	133,128	20,486	2,441	3,844	11,047	3,154	711
Comprehensive II	6,707	519	42	71	366	40	37
Liberal arts I	4,779	1,016	148	22	800	46	0
Liberal arts II	3,624	463	47	8	392	16	28
Specialized	20,708	2,038	465	522	405	646	63
Other	3,917	1,552	37	65	1,264	186	51
Not classified	765	66	0	14	52	0	0
		ı	Doctoral degree	es			
Total	44,513	25,921	10,219	2,069	7,521	6,112	19
Research I	28,548	17,837	7,504	1,536	4,111	4,686	7
Research II	5,034	2,874	1,161	235	775	703	0
Doctorate-granting I	4,633	2,199	505	194	1,169	331	0
Doctorate-granting II	2,101	1,261	442	95	417	307	0
Comprehensive I	723	224	47	0	132	45	12
Comprehensive II	12	12	3	0	9	0	0
Liberal arts I	167	49	18	5	26	0	0
Liberal arts II	42	15	0	0	15	0	0
Specialized	2,241	641	538	2	68	33	0
Other	985	809	1	2	799	7	0
Not classified	27	0	0	0	0	0	0

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

SOURCES: National Center for Education Statistics, Completion Survey (Washington, DC: 1995); and National Science Foundation, Science Resources Studies Division, unpublished tabulations.

See figures 2-5 and 2-7.

^bSocial sciences include psychology, sociology, and other social sciences.

[°]Engineering technology data are not included in "Total S&E."

Appendix table 2-10. Number of institutions awarding science and engineering degrees, by degree level and institution type: 1995

Institution type	Total institutions	Total S&E	Natural sciences ^a	Math & computer sciences	Social sciences ^b	Engineering	Engineering technology ^c
		E	Bachelor's degre	es			
Total	1,810	1,457	1,286	1,296	1,355	398	346
Research I	88	87	87	86	86	78	21
Research II	38	38	38	38	38	34	15
Doctorate-granting I	49	48	45	46	48	24	16
Doctorate-granting II	59	58	58	57	56	40	21
Comprehensive I	438	433	416	421	430	127	155
Comprehensive II	93	93	87	83	91	15	18
Liberal arts I	163	157	153	149	157	21	0
Liberal arts II	462	440	374	362	410	34	59
Two-year	44	11	1	4	5	1	11
Specialized	352	77	18	44	23	18	28
Other	18	13	8	4	10	6	1
Not classified	6	2	1	2	1	0	1
Not classified	0		Master's degree		I	<u> </u>	<u>'</u>
Total	1,312	746	474	434	611	265	78
Research I	87	87	87	84	87	79	11
Research II	38	38	38	38	38	33	4
Doctorate-granting I	49	49	46	44	46	20	8
Doctorate-granting I	59	59	55	49	52	36	6
Comprehensive I	437	345	191	187	291	71	40
-	92	28	6	5	291 17	2	2
Comprehensive II	58	24		5 7	18	2	0
Liberal arts I			11				
Liberal arts II	158	24	5	1	19	2	2
Specialized	301	69	33	16	20	18	4
Other	31	22	2	2	22	2	1
Not classified	2	1	0	1	1	0	0
			Doctoral degree				
Total	479	329	257	171	258	170	4
Research I	88	88	88	81	87	78	2
Research II	38	38	38	36	36	32	0
Doctorate-granting I	50	50	37	28	48	18	0
Doctorate-granting II	59	56	44	23	39	27	0
Comprehensive I	74	30	13	0	15	8	2
Comprehensive II	2	2	1	0	1	0	0
Liberal arts I	11	5	2	1	4	0	0
Liberal arts II	4	1	0	0	1	0	0
Specialized	127	39	33	1	8	6	0
Other	25	20	1	1	19	1	0
Not classified	1	0	0	0	0	0	0

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

SOURCES: National Center for Education Statistics, Completion Survey (Washington, DC: 1995); and National Science Foundation, Science Resources Studies Division, unpublished tabulations.

See figure 2-5.

^bSocial sciences include psychology, sociology, and other social sciences.

^cEngineering technology data are not included in "Total S&E."

Appendix table 2-11. Total undergraduate enrollment, by race/ethnicity, citizenship, and sex: 1978-95

Race/ethnicity and citizenship	1978	1980	1982	1984	1986	1988	1990	1992	1993	1994	1995
				'	All students						
Total	9,808,815	9,821,513	10,205,475	10,081,336	10,952,167	11,453,788	12,011,657	12,693,778	12,482,813	12,417,701	12,399,826
White	7,872,635	7,827,035	8,060,213	7,635,957	8,406,100	8,737,576	9,232,090	9,388,226	9,101,085	8,905,614	8,806,202
Asian	206,065	225,422	280,062	296,123	384,004	431,053	491,134	620,463	642,893	683,131	700,828
Black	968,059	968,481	956,510	860,322	982,214	1,002,515	1,125,591	1,282,732	1,292,621	1,319,262	1,336,052
Hispanic	501,053	523,021	582,726	547,837	691,621	741,814	840,370	1,032,817	1,064,348	1,120,929	1,167,472
Native American	71,891	70,553	74,123	66,120	81,356	84,108	95,135	110,879	112,727	117,856	120,728
Foreign citizen	170,517	201,034	212,999	200,146	199,921	202,815	227,337	258,661	269,139	270,909	268,544
					Males						
Total	4,814,322	4,723,979	4,910,480	4,787,658	5,078,768	5,192,254	5,396,557	5,644,113	5,547,126	5,484,342	5,467,370
White	3,884,778	3,785,209	3,881,826	3,635,294	3,908,642	3,979,958	4,165,862	4,195,726	4,067,289	3,958,270	3,918,342
Asian	108,261	117,574	148,969	156,947	201,591	221,673	250,287	308,564	318,289	335,737	342,084
Black	416,816	407,497	400,746	352,703	396,749	395,359	440,209	496,123	500,194	503,381	507,380
Hispanic	244,149	244,444	270,386	250,043	313,108	329,866	371,232	453,488	467,155	490,827	505,162
Native American	33,481	31,621	33,589	29,498	35,592	35,501	39,692	46,572	47,233	48,920	50,223
Foreign citizen	116,583	134,864	143,000	132,496	127,364	122,320	129,275	143,640	146,966	147,207	144,179
					Females						
Total	4,994,493	5,097,534	5,294,995	5,293,678	5,873,399	6,261,534	6,615,100	7,049,665	6,935,687	6,933,359	6,932,456
White	3,987,857	4,041,826	4,178,387	4,000,663	4,497,458	4,757,618	5,066,228	5,192,500	5,033,796	4,947,344	4,887,860
Asian	97,804	107,848	131,093	139,176	182,413	209,380	240,847	311,899	324,604	347,394	358,744
Black	551,243	560,984	555,764	507,619	585,465	607,156	685,382	786,609	792,427	815,881	828,672
Hispanic	256,904	278,577	312,340	297,794	378,513	411,948	469,138	579,329	597,193	630,102	662,310
Native American	38,410	38,932	40,534	36,622	45,764	48,607	55,443	64,307	65,494	68,936	70,505
Foreign citizen	53,934	66,170	66,69	67,650	72,557	80,495	98,062	115,021	122,173	123,702	124,365

SOURCES: National Center for Education Statistics (NCES), Digest of Education Statistics (Washington, DC: U.S. Government Printing Office, 1994); NCES, Trends in Racial/Ethnic Enrollment in Higher Education: Fall 1982 Through Fall 1995 (Washington, DC: U.S. Government Printing Office, 1997); and NCES, unpublished tabulations.

Appendix table 2-12. Undergraduate enrollment in engineering and engineering technology programs: 1979-96

Enrollment	1979	1981	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
						Engine	Engineering programs	grams								
Total students	366,299	420,402	441,205	429,499	l	407,657	392,198	385,412	378,277	380,287	379,977	382,525	375,944	367,298	363,315	356,177
Total full time	340,488	387,577	406,144	394,635		369,520	356,998	346,169	338,529	338,842	339,397	344,126	337,817	328,463	325,489	317,772
Freshman	103,724	115,280	109,638	105,249	103,225	99,238	95,453	600'86	95,420	94,346	93,002	93,427	88,875	85,047	86,299	85,375
Sophomore	78,594	87,519	89,515	83,946		76,195	73,317	71,030	71,267	72,204	71,257	71,644	69,974	68,177	67,981	66,475
Junior	74,928	86,633	91,233	89,509	84,875	80,386	77,085	73,761	70,483	72,666	73,516	74,871	73,449	71,753	68,894	67,190
Senior	77,823	92,414	109,036	109,695	_	107,773	104,003	97,614	94,465	92,989	94,683	98,235	98,214	96,523	95,226	92,213
Fifth year	5,419	5,731	6,722	6,236		5,928	7,140	5,755	6,894	6,637	6,939	5,949	7,305	6,963	7,089	6,519
Total part time	25,811	32,825	35,061	34,864	36,673	38,137	35,200	39,243	39,748	41,445	40,580	38,399	38,127	38,835	37,826	38,405
Total schools	286	286	292	289		311	316	320	323	328	336	337	336	337	337	335
ABET-accredited schools ^a	239	250	258	258	264	270	277	281	284	289	303	309	310	315	316	317
					Enç	ineering	technolo	Engineering technology programs	ms							
Total students	Ą	191,152	191,152 163,226	157,897	123,571	137,390	128,501	131,704	127,687	123,217	127,135	124,736	106,976	107,275	105,809	105,345
Total full time	Α	134,444	112,745	111,446		90,536	80,600	79,624	76,179	72,390	75,340	73,245	65,581	66,457	63,929	62,330
First year	₽	65,893	53,032	46,806		39,177	32,685	33,477	32,225	30,178	31,302	30,543	24,824	24,574	25,665	26,583
Second year	₹	40,774	33,799	31,716	23,293	25,612	22,906	21,852	21,627	20,586	20,815	21,081	19,962	20,997	18,863	17,267
Other years assoc	¥	872	925	1,165		657	1,404	1,760	1,810	1,603	2,221	2,336	2,564	3,121	2,007	2,780
BA of engineering tech																
Third and later years	¥	26,905	24,989	31,759	24,890	25,090	23,605	22,535	20,517	20,023	21,002	19,285	18,231	17,765	17,394	15,700
Total part time	Α	56,708	50,481	46,451	40,533	46,854	47,901	52,080	51,508	50,827	51,795	51,491	41,395	40,818	41,880	43,015

NA = not available

Total schools

^aSchools with at least one curriculum accredited by the Accreditation Board of Engineering and Technology (ABET).

SOURCE: American Association of Engineering Societies, Engineering Workforce Commission, Engineering and Technology Enrollments, Fall 1979-1996 (Washington, DC: 1996), unpublished tabulations.

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Appendix table 2-13. **Engineering enrollment, by attendance pattern: 1979-96**

		Undergraduate			Graduate	
-	Total	Full time	Part time	Total	Full time	Part time
		Nun	nber			
1979	366,299	340,488	25,811	67,152	41,384	25,768
1980	397,344	365,117	32,227	72,585	44,335	28,250
1981	420,402	387,577	32,825	77,600	47,782	29,818
1982	435,330	403,390	31,940	81,999	50,410	31,589
1983	441,205	406,144	35,061	91,040	57,366	33,674
1984	429,499	394,635	34,864	93,165	57,277	35,888
1985	420,864	384,191	36,673	95,505	60,641	34,864
1986	407,657	369.520	38,137	107.196	67,333	39,863
1987	392,198	356,998	35,200	110,778	69,343	41,435
1988	385,412	346,169	39,243	112,007	69,226	42,781
1989	378,277	338,529	39,748	114.048	68,967	45.081
1990	380,287	338.842	41,445	117.834	72.456	45,378
1991	379.977	339.397	40.580	123,497	74.568	48,929
1992	382,525	344,126	38,399	128,854	78,651	50,203
1993	375,944	337,817	38,127	128,081	78,885	49,196
1994	367,298	328,463	38,835	122,242	74,596	47,646
1995	363,315	325,489	37,826	118,506	72,215	46,291
1996	356,177	317,772	38,405	113,063	70,129	42,934
1000	000,111		cent	110,000	70,120	12,001
1979	100.0	93.0	7.0	100.0	61.6	38.4
1980	100.0	91.9	8.1	100.0	61.1	38.9
1981	100.0	92.2	7.8	100.0	61.6	38.4
1982	100.0	92.7	7.3	100.0	61.5	38.5
1983	100.0	92.1	7.9	100.0	63.0	37.0
1984	100.0	91.9	8.1	100.0	61.5	38.5
1985	100.0	91.3	8.7	100.0	63.5	36.5
1986	100.0	90.6	9.4	100.0	62.8	37.2
1987	100.0	91.0	9.4	100.0	62.6	37.4
	100.0				61.8	38.2
1988		89.8	10.2	100.0		36.∠ 39.5
1989	100.0	89.5	10.5	100.0	60.5	
1990	100.0	89.1	10.9	100.0	61.5	38.5
1991	100.0	89.3	10.7	100.0	60.4	39.6
1992	100.0	90.0	10.0	100.0	61.0	39.0
1993	100.0	89.9	10.1	100.0	61.6	38.4
1994	100.0	89.4	10.6	100.0	61.0	39.0
1995	100.0	89.6	10.4	100.0	60.9	39.1
1996	100.0	89.2	10.8	100.0	62.0	38.0

SOURCE: American Association of Engineering Societies, Engineering Workforce Commission, *Engineering and Technology Enrollments, Fall 1979-1996* (Washington, DC: 1996), unpublished tabulations.

Appendix table 2-14. Undergraduate enrollment in engineering, by sex, race/ethnicity, and citizenship: 1979-96

					R	ace/ethnicit	ty and citize	enship		
		Se	ex			ι	Inderrepres	sented minor	rities	
	Total	Male	Female	White	Asian	Total	Black	Hispanic	Native American	Foreign citizen
				Num	nber					
1979	366,299	321,868	44,431	302,566	12,243	28,729	15,842	12,068	819	22,761
1981	420,402	361,133	59,269	343,649	15,815	34,353	18,911	14,359	1,083	26,585
1983	441,205	372,374	68,831	354,329	23,007	37,432	19,698	16,462	1,272	26,437
1984	429,499	362,800	66,699	340,374	25,449	37,557	19,204	17,075	1,278	26,119
1985	420,864	354,612	66,252	323,899	28,767	39,657	19,819	18,598	1,240	28,541
1986	407,657	344,999	62,658	315,861	30,201	37,240	18,459	17,586	1,195	24,355
1987	392,198	331,917	60,281	296,749	32,795	38,640	19,142	18,253	1,245	24,014
1988	385,412	325,024	60,388	288,415	34,051	40,389	20,405	18,700	1,284	22,557
1989	378,277	318,067	60,210	281,948	33,360	41,338	21,013	19,007	1,318	21,631
1990	380,287	319,506	60,781	288,732	30,898	41,169	20,833	18,873	1,463	19,488
1991	379,977	316,719	63,258	271,906	37,803	48,692	24,563	22,441	1,688	21,576
1992	382,525	316,460	66,065	270,942	38,480	51,517	25,722	23,863	1,932	21,586
1993	375,944	309,412	66,532	263,073	37,835	52,437	25,920	24,586	1,931	22,599
1994	367,298	300,643	66,655	256,287	37,009	52,188	24,994	25,216	2,028	21,764
1995	363,315	296,029	67,286	249,896	38,329	53,670	25,569	25,998	2,103	21,420
1996	356,177	288,559	67,618	243,270	37,873	53,801	24,922	26,483	2,396	21,233
				Pero	ent					
1979	100.0	87.9	12.1	82.6	3.3	7.8	4.3	3.3	0.2	6.2
1981	100.0	85.9	14.1	81.7	3.8	8.2	4.5	3.4	0.3	6.3
1983	100.0	84.4	15.6	80.3	5.2	8.5	4.5	3.7	0.3	6.0
1984	100.0	84.5	15.5	79.2	5.9	8.7	4.5	4.0	0.3	6.1
1985	100.0	84.3	15.7	77.0	6.8	9.4	4.7	4.4	0.3	6.8
1986	100.0	84.6	15.4	77.5	7.4	9.1	4.5	4.3	0.3	6.0
1987	100.0	84.6	15.4	75.7	8.4	9.9	4.9	4.7	0.3	6.1
1988	100.0	84.3	15.7	74.8	8.8	10.5	5.3	4.9	0.3	5.9
1989	100.0	84.1	15.9	74.5	8.8	10.9	5.6	5.0	0.3	5.7
1990	100.0	84.1	16.0	75.9	8.1	10.8	5.5	5.0	0.4	5.1
1991	100.0	83.4	16.6	71.6	9.9	12.8	6.5	5.9	0.4	5.7
1992	100.0	82.7	17.3	70.8	10.1	13.5	6.7	6.2	0.5	5.6
1993	100.0	82.3	17.7	70.0	10.1	13.9	6.9	6.5	0.5	6.0
1994	100.0	81.9	18.1	69.8	10.1	14.2	6.8	6.9	0.6	5.9
1995	100.0	81.5	18.5	68.8	10.5	14.8	7.0	7.2	0.6	5.9
1996	100.0	79.4	18.6	67.0	10.4	14.8	6.9	7.3	0.7	5.8

SOURCE: American Association of Engineering Societies, Engineering Workforce Commission, *Engineering and Technology Enrollments, Fall 1979-1996* (Washington, DC: 1996), unpublished tabulations.

See figure 2-10.

Appendix table 2-15. Proportion of freshmen intending to major in science and engineering, by field, sex, and race/ethnicity: 1976-96 (Percentages)

Field and sex	1976	1978	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
All freshmen	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
							Whit	e stude	nts										
Total intending S&E majors	31.4	30.2	30.3	29.9	31.3	31.4	30.9	29.8	27.8	27.0	26.5	29.0	28.4	30.2	30.2	31.1	31.0	30.3	32.2
Natural sciences.	13.2	0.0	o 0	0. 1. 0.	7 r	- 1	- c		ວ (0.0	0.0	o 0	o. 0	o 0	א פ	0.0		0.2	9 1
Math & comp. sciences	2.3	5.6	3.1	4.7	5.9	2.7	χ. α.	3.1	5.5	2.2	2.1	2.3	2.2	2.1	2.1	2.4	2.3	2.5	2.7
Social sciences ^b	7.3	7.7	7.3	6.3	6.4	6.5	8.0	8.3	8.2	9.7	9.6	10.5	6.6	0.6	9.2	9.4	8.0	8.5	0.6
Engineering	8.6	10.3	11.4	10.9	11.6	11.5	11.0	10.7	10.2	8.6	8.2	9.3	8.8	10.6	9.4	9.3	7.9	7.3	8.9
Males intending S&E majors	41.7	39.3	40.6	40.5	41.5	42.5	41.0	38.7	35.9	34.0	33.7	36.6	35.3	37.5	37.4	38.2	37.5	36.8	38.8
Natural sciences ^a	16.6	11.8	10.4	10.2	6.6	10.0	9.6	9.4	8.2	7.9	8.5	8.2	9.0	8.7	10.4	11.0	12.7	12.7	11.5
Math & comp. sciences	2.7	3.0	3.7	5.6	9.9	9.9	4.9	4.0	3.3	3.2	3.0	3.4	3.0	3.0	2.9	3.5	3.5	4.2	4.3
Social sciences ^b	7.5	6.7	6.5	5.5	5.1	5.9	9.9	6.7	6.2	7.2	7.4	8.2	7.8	7.0	7.6	7.6	7.5	9.9	8.9
Engineering	14.9	17.8	20.0	19.2	19.9	20.0	19.9	18.6	18.2	15.7	14.8	16.8	15.5	18.8	16.5	16.1	13.8	13.3	16.2
Females intending S&E majors	20.9	21.1	20.1	21.0	21.6	21.7	21.3	21.6	20.1	21.0	20.6	22.9	22.5	24.1	24.1	24.9	25.6	25.3	26.5
Natural sciences ^a	9.4	7.7	6.2	6.1	5.3	2.7	6.2	6.2	5.7	5.2	5.1	0.9	0.9	8.4	8.2	9.1	11.0	11.6	11.5
Math & comp. sciences	1.9	2.2	5.6	3.9	5.3	4.9	2.7	2.1	1.8	1.3	4.1	1.3	1.6	1.3	1.3	1:	1.2	1.	1.2
Social sciences ^b	7.7	8.7	8.2	7.4	7.5	7.4	9.6	10.2	10.0	12.3	11.7	12.8	11.9	11.3	11.5	11.1	10.4	10.4	10.9
Engineering	1.9	2.5	3.1	3.6	3.5	3.7	2.8	3.1	5.6	2.2	2.4	2.8	3.0	3.1	3.1	3.6	3.0	2.2	2.9
							Asia	n stude	nts										
Total intending S&E majors	49.8	45.9	48.4	47.6	49.8	50.1	48.7	51.1	46.2	47.2	44.7	43.1	42.9	44.2	43.7	42.9	44.9	40.6	42.9
Natural sciencesa	20.3	16.1	11.9	12.7	13.3	15.0	15.2	15.9	14.5	15.1	14.6	11.9	12.8	14.7	16.1	16.2	16.4	15.3	16.2
Math & comp. sciences	3.8	4.1	5.0	6.1	7.3	7.5	5.4	3.2	4.2	3.9	3.3	2.7	3.5	3.6	2.5	2.9	4.2	4.6	4.9
Social sciences ^b	6.7	6.5	5.9	2.5	6.2	6.1	6.5	7.7	6.9	8.5	8.6	9.3	9.7	8.5	8.5	9.1	8.0	7.3	7.7
Engineering	17.8	19.2	25.6	23.1	23.0	21.5	21.6	24.3	20.6	19.7	17.0	19.2	16.9	17.4	16.6	14.7	16.3	13.4	14.1
Males intending S&E majors	60.3	55.2	59.3	58.3	59.6	59.8	59.9	0.09	56.2	55.5	52.8	51.8	52.3	54.1	51.3	50.8	52.6	48.5	50.1
Natural sciences ^a	20.9	15.8	13.5	13.2	14.7	16.9	16.3	15.7	14.9	14.5	15.5	13.1	14.4	15.5	16.3	16.3	16.3	15.1	15.0
Math & comp. sciences	3.8	4.0	3.8	5.4	2.7	9.9	5.5	3.1	4.4	4.6	3.9	3.1	4.7	4.8	3.6	4.1	2.8	6.5	7.3
Social sciences ^b	5.9	2.0	4.0	3.4	4.3	3.9	5.1	6.5	4.2	5.4	6.9	5.6	9.9	2.8	2.7	6.5	2.0	4.7	4.8
Engineering	29.7	30.4	38.0	36.3	34.9	32.4	33.0	34.7	32.7	31.0	26.5	30.0	26.6	28.0	25.7	23.9	25.5	22.2	23.0
Females intending S&E majors	38.3	36.7	34.7	36.3	40.0	39.5	37.4	40.4	36.2	37.8	36.2	34.7	33.8	34.6	36.2	34.9	36.4	33.7	35.3
Natural sciences ^a	19.6	16.5	10.1	11.9	11.7	12.9	14.0	16.2	14.3	15.5	13.7	11.4	1.1	14.3	15.7	15.8	16.7	15.8	17.0
Math & comp. sciences	3.7	4.3	6.5	7.0	9.1	8.4	5.4	3.3	4.1	3.2	2.8	2.4	2.4	2.4	1.6	1.9	2.4	2.7	2.5
Social sciences ^b	10.0	8.0	9.7	7.9	8.7	8.1	9.7	8.6	9.7	11.5	13.1	13.5	12.8	11.2	11.4	11.4	10.7	9.7	10.4
Engineering	2.0	7.9	10.5	9.5	10.5	10.1	10.4	12.3	8.1	9.7	9.9	7.4	7.5	6.7	7.5	2.8	9.9	5.5	5.4
							Blac	k stude	nts										
Total intending S&E majors	31.7	30.7	30.4	30.7	33.3	31.5	28.9	30.4	27.9	30.7	31.1	31.2	31.4	35.3	37.1	37.7	35.6	35.5	36.2
Natural sciences ^a	8.9	5.7	4.7	2.0	5.3	5.3	5.8	5.8	4.8	5.1	4.7	5.7	5.3	6.4	7.8	8.9	8.8	10.4	10.0
Math & comp. sciences	1.5	5.6	4.7	8.9	8.3	9.0	6.9	7.0	4.5	4.4	4.0	4.4	4.5	5.0	4.7	4.8	4.5	5.3	5.5
Social sciences ^b	14.7	14.1	10.7	9.0	8.3	8.4	8.7	8.1	10.2	10.7	14.3	11.9	12.7	11.6	11.9	1.1	12.7	11.2	11.6
Engineering	9.9	8.3	10.3	6.6	11.4	8.8	7.5	9.5	8.4	10.5	8.1	9.5	8.9	12.3	12.7	12.9	9.6	8.6	9.1

Engineering ...
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Appendix table 2-15. Proportion of freshmen intending to major in science and engineering, by field, sex, and race/ethnicity: 1976-96 (Percentages)

Field and sex	1976	1978	1980	1981	1982	1983	984	985	1986	987 1	. 886	686	1990	1991	1992	1993	1994	1995	966
Males intending S&E majors	34.2	33.1	34.8	35.9	38.5						34.1	34.2	32.8	39.7	41.8	42.8	38.1	37.7	37.2
Natural sciences ^a	10.4	0.9	2.0	5.7	2.8						5.7	2.5	5.7	0.9	7.7	8.5	 	9.4	7.7
Math & comp. sciences	9.0		4.0 8.1	7.0	ω.						4.2 2.1	1 2	5.0	2.0	2.0	5.7	2.0	9.0	ი. ი. ი
Social sciences"	0.0	χο ή 4. ι	ο ί υ ι	0 C	ა ქ						7.6	· · ·	4. 1	4. 6	0.7	4. 6	, c	0 i	N 5
Engineering	0.2.0	2.5	0.0 7	7.7	9.0						ນ (ນ (16.0	7.4.0	5.13	1.12	7.12	0.70		16.4
Females Intending S&E majors	74.0	23.3	4.57	2.4 د.ک	7.7						7.07	27.3 5.0	78.0	30.7	32. 0	δ. Δ. α	30.4 4.0	ر ا ا ا	32.1
Math 8 comp points	 	0 0	4	4. 0	4 o ยัก						- o	0 0	9.5	0 0	0 v		o <	- C	0.7
Matri & corrip. sciences	- c	3.5	4 c	0 0	0.0						0. Z	4. c	- 6 - 0	0.0	4. c	4 + 7 - 4	4 ¢	4. ±	4 °
Social sciences"		3.0	. 4 . 7.	ა 4 ა 9	5.9 9.9	. 4 5 C	3.7	, 4	0.0 6.3	ر 9.0	6.4 0.0	5.5 5.4	5.0	6.6 6.6	6.9	7.6	4. 4. 4. 0.	6. 4 6. 5.	4.5
							an	þ											
Total intending S&E majors	32.0	27.2	35.1	34.3	32.9	34.1					30.5		33.4	30.0	33.4	34.2	37.8	37.2	35.0
Natural sciencesa	11.6	8.9	8.9	9.3	8.9	8.4	8.1	8.8	9.8	8.2	8.9	7.3	7.4	7.4	8.8	9.4	10.2	11.0	6.6
Math & comp. sciences	1.7	2.0	3.1	3.5	5.2	4.7					2.1		2.3	5.6	2.4	2.0	5.6	5.6	2.9
Social sciences ^b	10.6	9.4	10.4	7.4	9.0	8.3					12.6		12.8	9.7	12.0	12.5	13.6	12.5	12.1
Engineering	8.1	9.0	12.7	14.1	11.9	12.7					0.6		10.9	10.3	10.2	10.3	11.4	1.1	10.1
Males intending S&E majors	39.5	34.0	41.3	41.7	39.8	40.3					35.4		39.0	34.8	37.6	38.7	42.1	41.4	41.2
Natural sciences ^a	14.0	7.8	9.4	9.0	7.9	8.8					7.5		8.9	7.4	9.5	8.6	10.4	9.1	6.6
Math & comp. sciences	5.6	3.3	2.7	4.0	5.1	5.5					2.7		2.7	3.6	3.2	2.8	4.0	3.9	4.3
Social sciences ^b	8.6	6.9	8.1	5.1	7.3	6.4					9.3		7.9	8.9	8.1	9.4	9.1	8.2	8.8
Engineering	14.3	16.0	21.1	23.6	19.5	19.6					15.9		19.5	17.0	17.1	16.7	18.6	20.2	18.2
Females intending S&E majors	24.0	21.0	30.0	26.9	26.6	28.7					26.7		28.9	25.7	29.6	29.6	34.7	32.0	30.1
Natural sciences ^a	8.9	6.1	8.7	9.4	5.6	8.0					6.1		6.2	7.9	8.5	8.7	10.2	1.1	9.6
Math & comp. sciences	6.0	6.0	3.5	2.9	5.4	4.0					1.7		2.1	1.7	1.6	1.2	1.6	1.4	6.
Social sciences ^b	12.8	11.9	12.4	9.5	10.5	10.3					15.3		16.2	12.4	15.3	15.3	17.2	16.0	14.6
Engineering	1.4	2.1	5.4	5.4	5.1	6.4					3.6		4.4	3.7	4.2	4.4	2.2	3.5	4.0
						Nat	ive Ame	rican st	students										
Total intending S&E majors	30.5	32.0	34.0	26.8	27.7				29.6		30.8	32.7	30.9	30.3	30.9	30.8	30.0	29.8	32.2
Natural sciences ^a	13.7	9.3	9.7	9.9	6.7				7.8		7.4	6.5	10.7	8.4	9.1	9.2	9.4	11.3	11.8
Math & comp. sciences	2.5	2.2	3.9	3.0	4.6				2.3		2.3	1.8	9.1	2.4	5.0	2.4	2.4	2.5	3.3
Social sciences ^b	7.8	10.2	9.5	7.0	5.9				9.2		12.6	13.9	10.6	9.6	10.6	10.6	10.3	9.6	10.2
Engineering	6.5	10.3	13.3	10.2	10.5				10.0		8.5	10.5	8.0	6.6	9.5	8.3	6.8	6.4	6.9
Males intending S&E majors	39.4	38.1	41.5	39.2	34.2				39.7		37.3	39.1	35.9	36.6	37.6	36.5	34.1	36.3	38.5
Natural sciences ^a	17.2	11.8	6.6	8.8	6.9				8.6		9.5	8.5	12.3	8.4	9.6	11.7	10.0	11.8	11.6
Math & comp. sciences	3.4	1 .	4.8	4.7	6.1				3.0		3.4	5.0	2.2	3.3	3.0	5.8	3.5	4.3	2.7
Social sciences ^b	7.0	7.5	7.5	6.2	2.7				9.2		8.5	11.4	7.4	2.9	9.5	8.3	8.1	7.3	7.8
Engineering	11.8	16.9	19.3	19.5	18.5				17.4		15.9	17.2	14.0	18.2	15.8	13.7	12.5	12.9	13.4
Females intending S&E majors	21.8	25.9	26.7	15.6	22.4				21.4		25.6	28.1	26.8	25.5	25.6	26.5	26.5	25.2	27.5
Natural sciencesa	10.6	6.0 6.0	5.3	5.5	6.7				5.9		5.7	5.2	9.1	ان	8.5	7.8	10.1	1.0	11.7
Math & comp. sciences	9. r	9.0	χ, τ τ	ر 1.5	 	4 (4. •	3.7	5.2	 ∞. r	o ,	4. 4	ر. د ر	. ငု လ (7.7	2.5	2.7	ر د ب	2.5	9 1
Social sciences ^p	3.5	72.8 0.0	5.11).	، œ ۱ رو				ი. ი.		16.1	15.6	13.0	11.9	χ. <u>.</u>	12.2	12.1	71.2	۱۱./ <u>.</u> -
Engineering	- -	3.6	6.9	9.	3.7				4.2		2.4	2.8	3.4	3.4	4.1	4.4	2.8	. 8.	2.5
	porth	atmocnhe	rio Orași	ouranhin	hioloid	and agr	o leti itali o	o cocio											

^{*}Natural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

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^bSocial sciences include psychology, sociology, and other social sciences.

SOURCE: University of California at Los Angeles, Higher Education Research Institute, Survey of the American Freshman: National Norms (Los Angeles: 1995), unpublished tabulations.

Appendix table 2-16. Race/ethnicity of freshmen intending to major in science and engineering, by selected fields: 1976-96 (Percentages)

Field/subfield	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989 1	. 0661	1991	1992	1993	1994	1995	9661
						>	White freshmen intending S&E majors	shmen	intendi	ng S&E	majors										
All S&E fields	87.6	87.1	87.9	86.2	85.9	87.4	85.2	85.7	85.9	84.1	84.1 87.4	83.1	80.2	81.9	78.9	76.9	78.9	79.1	76.7	76.5	76.7
Biological sciences	88.8	89.4	89.0	88.1	88.3	87.8	85.8	85.2	84.2	83.8	82.7	8.18	79.9	80.8	77.8	76.2	78.4	78.6	77.8	76.6	76.4
Social sciences	84.0	83.1	83.5	83.3	83.4	87.0	84.7	84.8	85.4	87.2	84.4	85.0	80.5	83.6	78.2	77.8	80.0	80.1	7.77	77.6	7.77
Engineering	88.8	88.0	89.2	86.7	86.1	87.5	82.8	87.3	87.8	83.4	84.1	81.6	80.2	81.1	79.3	76.1	77.2	77.3	73.8	74.3	76.0
						Asi	sian fre	shmen	ian freshmen intending S&E	ng S&E	majors										
All S&E fields	1.8	1.8	1.8	2.2	2.2	2.0	2.5	2.8	2.7	4.4	4.6	4.8	5.2	4.8	5.3	0.9	5.8	2.2	7.9	7.0	8.9
Physical sciences	2.3	2.7	2.3	2.8	2.3	2.8	3.6	3.5	4.0	6.1	5.4	2.0	5.5	4.4	5.4	5.8	5.9	5.5	8.0	8.9	9.9
Biological sciences	2.1	2.1	2.3	2.2	2.5	2.5	3.2	4.2	3.9	9.9	7.1	7.7	8.6	7.0	7.7	9.5	8.4	8.1	9.8	8.6	8.5
Social sciences	0.0	1.0	1.0	0.9	1.6	4.1	1.6	2.5	2.5	2.8	3.4	3.1	3.7	4.2	3.8	4.5	5.0	8.8	4.6
Engineering	2.4	2.4	2.2	3.1	2.9	2.7	3.0	3.4	3.5	2.7	5.8	0.9	6.4	6.4	6.4	6.7	6.9	6.3	10.5	8.9	8.0
						B	Black freshmen		intendi	intending S&E	majors	ا ا									
All S&E fields	8.5	8.6	8.2	9.1	9.7	8.6	10.4	9.7	9.5	9.4	8.6	9.6	11.6	10.3	12.1	13.2	11.2	11.4	11.1	11.5	11.7
Physical sciences	6.3	5.0	4.7	5.8	0.9	5.6	6.9	0.9	5.6	7.7	5.3	2.5	5.3	7.2	5.3	8.6	7.2	9.0	8.7	8.1	9.1
Biological sciences	6.9	6.2	6.3	6.7	7.0	7.1	8.9	7.9	9.5	8.9	8.9	9.7	8.1	0.6	10.2	10.0	8.9	9.5	8.4	10.6	10.3
Social sciences	12.5	12.8	12.7	12.7	12.4	10.1	10.7	11.9	11.4	8.9	10.3	9.7	13.0	10.2	14.1	13.7	11.5	10.9	12.1	11.5	12.8
Engineering	6.8	7.3	6.7	7.7	8.7	9.7	9.4	9.7	7.0	8.5	7.4	9.8	10.1	9.4	10.6	13.4	12.2	12.7	11.0	10.9	10.7
						His	Hispanic freshmen intending S&E	eshme	n intenc	Jing S&	E majors	LS.									
All S&E fields	1.3	1.9	4.1	2.0	1.6	1.3	1.8	1.3	1.2	1.6	2.1	1.9	2.3	2.3	2.5	2.7	4.1	5.9	7.1	7.6	8.0
Physical sciences	1.3	9.0	1.	1.5	1.2	1.3	1.0	0.7	1.2	1.0	1.2	1.4	1.7	1.7	1.8	2.1	5.6	2.9	4.0	2.8	3.4
Biological sciences	1.9	1.9	1.9	2.2	1.9	5.6	2.0	1.8	1.9	1.8	2.2	2.2	2.7	2.2	2.5	2.8	4.2	5.9	4.1	4.5	4.6
Social sciences	1.8	5.6	2.0	2.6	2.1	4.	2.0	1.5	1.2	1.5	2.1	1.9	2.5	2.4	2.7	2.9	4.9	7.5	5.6	6.1	2.8
Engineering	1.1	1.5	1.3	1.6	1.3	1.3	1.7	1.3	1.1	1.5	2.1	1.9	2.2	2.2	2.5	2.5	3.9	5.3	5.3	5.9	5.1
						Native ,	American freshmen intending	an frest	ımen in	ntendin	S&E	majors									
All S&E fields	0.9	0.7	0.7	0.8	0.8	6.0	6.0	1.0	6.0	6.0	6.0	1.0	6.0	1.0	1.3	1.7	1.8	1.8	2.1	2.1	2.3
Physical sciences	1.2	0.5	9.0	1.0	9.0	0.8	6.0	1.3	9.0	0.8	1.	1.	9.0	6.0	2.1	1.5	1.5	1.3	2.1	2.2	2.9
Biological sciences	1.0	0.8	0.7	0.7	0.8	0.8	1.0		1.5	1.2	1.0	[1.0	6.0	1.6	1.8	1.8	1.9	2.0	2.3	2.3
Social sciences	1.0	0.8	0.8	0.8	0.0	- -	6.0	4.	9.0	0.9	1.0	1.0	0.9	1.2	1.3	1.9	1.8	2.3	2.2	2.5	2.2
Engineering	0.7	0.5	9.0	0.7	0.7	0.9	6.0	0.9	0.7	9.0	6.0	1.0	0.8	1.0	-	1.5	1.6	1.5	1.7	1 .8	1 .8
																					l

NOTE: Details may not add to totals because students may check more than one race/ethnicity, e.g., white and Hispanic.

SOURCE: University of California at Los Angeles, Higher Education Research Institute, Survey of the American Freshman: National Norms (Los Angeles: 1997), unpublished tabulations.

figure 2-9.

Science & Engineering Indicators – 1998

Appendix table 2-17.

Freshmen reporting need for remedial work in science or mathematics, by intended major, sex, and race/ethnicity: 1995 (Percentages)

	All S&E majors needing remedial work in:	najors emedial in:	Physical science needing reme work in:	science majors ng remedial vork in:	Biological science majors needing remedial work in:	ence majors emedial in:	Social science majors needing remedial work in:	ce majors emedial in:	Engineering majors needing remedial work in:	g majors emedial in:	Non-S&E majors needing remedial work in:	najors medial n:
Sex, race/ethnicity	Science	Math	Science	Math	Science	Math	Science	Math	Science	Math	Science	Math
All students	9.5	21.2	6.2	13.0	9.7	22.0	10.5	27.5	9.0	14.3	10.9	25.0
Male	7.6	16.4	5.3	11.3	13.2	25.2	7.0	20.2	8.3	13.9	8.4	20.8
Female	11.4	26.6	7.6	15.5	10.8	24.4	12.8	32.2	12.2	15.5	12.7	28.0
White	6.8	17.8	4.4	11.1	8.9	19.1	8.5	24.2	2.7	10.3	9.0	22.0
Asian	15.9	20.6	11.1	10.2	15.4	20.3	20.0	26.9	14.8	18.1	22.8	25.7
Black	20.2	41.8	23.0	39.9	23.8	41.8	16.1	47.5	19.0	31.1	18.8	47.1
Hispanic	21.6	38.3	10.4	20.7	19.9	36.3	20.0	41.2	25.9	34.1	18.1	37.0
Native American	12.0	29.8	2.7	8.6	13.6	33.7	10.9	36.3	14.3	17.8	12.5	39.1

SOURCE: University of California at Los Angeles, Higher Education Research Institute, Survey of the American Freshman: National Norms (Los Angeles: 1997), unpublished tabulations.

Science & Engineering Indicators - 1998

See figure 2-8.

Appendix table 2-18. Earned associate degrees, by field and sex: 1975-95

Field	1975	1977	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
								*	All students										
All degrees	362,969	409,942	407,471	405,710	420,910	440,000	461,888	457,851		451,258	440,816	441,093				508,704	519,098	546,574	544,094
S&E	¥	¥	Ϋ́	₹	Ϋ́	¥	23,796	28,095		25,267	23,130	21,520	19,733			22,722	23,420	25,581	24,228
Natural sciences ^a .	× ×	¥	Ϋ́	₹	Α	¥	5,013	4,990		3,924	3,694	3,818	3,712			4,585	4,787	5,484	5,456
Math & comp. sci.	¥	¥	Ϋ́	¥	Ϋ́	¥	10,707	13,696		11,567	9,953	9,575	8,846			10,376	10,275	10,634	10,410
Social sciences ^b	¥	Ą	Ϋ́	¥	Ϋ́	Α	4,803	4,852	4,562	4,487	4,894	4,231	4,440	4,809	4,087	5,046	5,832	6,619	6,077
Engineering	× ×	¥	Ϋ́	₹	Α	¥	3,273	4,557		5,289	4,589	3,896	2,735			2,715	2,526	2,844	2,285
Engineering tech	30,906	38,588	41,716	43,696	52,478	58,574	51,317	50,671		49,880	49,815	49,646	48,342			40,592	40,946	42,414	39,190
									Males										
All degrees191,855	191,855	212,120	193,696	185,329	190,152	198,698	208,830	204,517	204,325	197,955	192,227	191,912	187,125			208,856	213,263	222,247	219,704
S&E	¥ :	¥	Ϋ́	¥	Ϋ́	Α	13,145	15,689	14,695	14,403	13,152	12,266	10,607			12,063	12,103	13,023	12,461
Natural sciences ^a .	¥	¥	Ϋ́	₹	Ϋ́	¥	2,959	2,927	2,460	2,173	2,113	2,151	1,965	2,195	2,278	2,605	2,686	2,948	2,978
Math & comp. sci.	A	N	N A	Ν	ΑΝ	N	5,395	7,007	7,128	6,015	5,297	5,028	4,563			5,187	5,123	5,384	5,434
Social sciences ^b	. A	₹	Ν	¥	Α	Α	1,876	1,713	1,606	1,588	1,650	1,617	1,671			1,911	2,098	2,217	2,071
Engineering	N	₹	Ϋ́	₹	Ϋ́	₹	2,915	4,042	3,501	4,627	4,092	3,470	2,408			2,360	2,196	2,474	1,978
Engineering tech	29,108	34,957	36,749	37,847	45,329	50,823	45,521	45,068	47,946	44,340	44,158	44,053	42,766			35,666	36,129	36,899	34,196
									Females										
All degrees171,114	171,114	197,822 213,775	213,775	220,381	230,758	241,302	253,058	253,334		253,303	248,589	249,181	253,250		286,254	299,848	305,835	324,327	324,390
S&E	¥	¥	Ϋ́	¥	Ϋ́	Α		12,406		10,864	9,978	9,254		9,242	٠.	10,659	11,317	12,558	11,767
Natural sciences ^a	×N	₹	Ϋ́	¥	Ϋ́	₹	2,054	2,063		1,751	1,581	1,667		1,801		1,980	2,101	2,536	2,478
Math & comp. sci	NA	Ν	NA	Ν	NA	Ν	5,312	6,689		5,552	4,656	4,547	4,283	4,169	4,202	5,189	5,152	5,250	4,976
Social sciences ^b	N	¥	Ϋ́	¥	Ϋ́	¥	2,927	3,139		2,899	3,244	2,614	_	2,984		3,135	3,734	4,402	4,006
Engineering	¥ :	¥	¥	¥	¥	¥	358	515		662	497	426		288		355	330	370	307
Engineering tech	1,798	3,631	4,967	5,849	7,149	7,751	5,796	5,603	5,721	5,540	2,657	5,593	5,576	5,503	5,329	4,926	4,817	5,515	4,994
NA = not available																			

NOTE: Data on associate degrees are not available for broad science and engineering fields before 1983.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

^bSocial sciences include psychology, sociology, and other social sciences.

SOURCES: National Center for Education Statistics, Earned Degrees and Completion Surveys (Washington, DC: 1995), unpublished tabulations; and National Science Foundation, Science Resources Studies Division, unpublished tabulations.

Appendix table 2-19. Earned associate degrees, by field and race/ethnicity: 1977-95

All degrees All students All students All students Science and engineering NA NA NA NA 4.69 10 4.09 50 42 4.09 40 40 4.09 50 60 4.40 516 4.00 375 4.50 048 5.00 42 9.00 8	8 486,297 508,704 6 19,154 22,361 6 4,430 4,859 0 8,640 10,346 8 3,574 4,441 2 2,510 2,715 9 42,595 38,015	519 098	
MA	486,297 56 19,154 4,430 8,640 3,574 2,510 42,595	519 098	
NA	19,154 4,430 8,640 3,574 2,510 42,595	, 000,010	546,574 544,094
NA	4,430 8,640 3,574 2,510 42,595	23,118	25,172 23,644
NA NA 13,679 9,953 8,846 NA NA 3,674 3,949 3,949 NA NA 3,664 3,676 3,949 38,244 40,891 51,661 51,579 47,434 46,180 38,244 40,891 51,661 51,579 47,434 46,180 342,382 331,173 339,183 355,422 345,546 330,557 34 NA NA NA 18,133 16,169 13,898 13,898 13,31 NA NA NA 10,255 7,360 6,044 6,044 NA NA NA 10,255 7,360 6,044 6,044 NA NA NA 10,255 7,360 6,044 6,044 NA NA NA 10,250 3,736 3,231 1,369 11,369 NA NA NA 1,657 1,383 35,185	8,640 3,574 2,510 42,595	5,090	
NA	3,574	10,255	10,532 10,230
38,244 40,891 51,661 51,579 47,434 46,180 46,180 342,382 331,173 339,183 355,422 345,546 330,557 3.231 342,382 331,173 339,183 355,422 345,546 330,557 3.231 NA NA 10,255 7,360 6,044 40,444 40,934 37,383 3,584 5,637 NA NA NA 2,260 3,236 1,986 2,637 NA NA NA 2,260 3,236 1,986 2,637 NA NA NA 2,260 3,236 2,637 1,761 1 NA NA NA 2,260 3,238 33,584 3 4 NA NA NA AQ,934 37,383 33,584 3 4 NA NA<	42,595	5,248	
Whites Whites Whites Whites Whites Whites Whites Whites Water Water Whites Water Wat	42,595	2,525	2,828 2,276
Whites 342,382 331,173 339,183 355,422 345,546 330,557 33 342,382 331,173 339,183 355,422 345,546 330,557 33 NA NA NA 10,256 7,360 6,044 NA NA NA 2,260 3,235 1,986 33,109 33,662 40,804 40,934 37,383 33,584 0 NA NA NA 2,260 3,235 1,986 2,637 NA NA NA 40,934 40,934 33,584 0 NA NA NA 40,934 37,383 33,584 0 NA NA NA A7 10,61 119 NA NA NA A7 106 119 NA NA NA 1,570 1,989 1,460 NA NA NA 1,653 1,766 1,460 NA NA NA 1,653 1,766 1,460	098 928	38,473	36,956
342,382 331,173 339,183 355,422 345,546 330,557 3 NA NA 18,133 16,169 13,898	276 960		
NA NA 18,133 16,169 13,898 NA NA 3,548 3,078 3,231 NA NA 10,255 7,360 6,044 NA NA 10,255 7,360 6,044 NA NA 2,070 2,496 2,637 NA NA 2,260 3,235 1,986 33,109 33,662 40,804 40,934 37,383 33,584 3 33,109 33,662 40,804 40,934 37,383 33,584 3 NA NA NA 40,934 40,934 37,383 33,584 3 NA NA NA 828 1,051 834 401 NA NA NA 1464 401 119 NA NA 1,641 1,570 1,989 1,663 1,460 NA NA NA 1,653 1,766 1,4	00000	392,637	419,962 408,126
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NA NA 10,255 7,360 6,044 NA NA 2,070 2,496 2,637 NA NA 2,070 2,496 2,637 NA NA 40,934 37,383 33,584 3 33,109 33,662 40,804 40,934 37,383 33,584 3 7,174 7,617 8,757 10,165 11,329 11,761 120 NA NA NA 86 112 120 NA NA 47 106 119 NA NA 184 369 194 NA NA 1,570 1,989 1,663 33,176 34,985 35,330 35,861 33,868 32,185 3 NA NA NA 1,653 1,663 1,460 1,460 NA NA NA 1,663 1,460 1,460 1,460 <th>3,574</th> <th>3,989</th> <th></th>	3,574	3,989	
NA NA NA 2,070 2,496 2,637 NA NA NA 2,260 3,235 1,986 NA NA NA 2,260 3,235 1,986 Asians	6,054	6,515	
NA NA 2,260 3,235 1,986 2,584 3 33,109 33,662 40,804 40,934 37,383 33,584 3 7,174 7,617 8,757 10,165 11,329 11,761 1 NA NA NA 828 1,051 834 NA NA 112 401 119 NA NA 47 106 119 NA NA 144 464 401 NA NA 144 369 194 NA NA 144 369 1460 NA NA 1453 1,766 1,460 NA NA 1,653 1,766 1,460 <td>2,347</td> <td>3,241</td> <td></td>	2,347	3,241	
Mains Asians Asians 40,804 40,934 37,383 33,584 3 Asians Asians 11,761 1 MA NA R28 1,051 834 MA NA 828 1,051 834 MA NA NA 464 401 MA NA A7 106 119 MA NA 144 369 194 MA NA 1,570 1,989 1,663 MA NA 1,653 1,766 1,460 MA NA 1,653 1,766 1,460 MA NA NA 1,663 1,766 1,460 MA NA NA 1,663 1,766 1,460 MA NA NA 1,670 1,766 1,460 MA NA	1,867	1,886	
Asians 7,174 7,617 8,757 10,165 11,329 11,761 17,61 NA NA 828 1,051 834 NA NA 86 1,12 120 NA NA 47 106 119 NA NA 47 106 119 NA NA 47 106 119 NA NA 144 401 119 NA NA 144 369 1460 NA NA 1,550 1,766 1,460 NA NA 1,653 1,766 1,460 NA NA 1,653 1,766 1,460 NA NA NA 1,663 1,766 1,460 NA NA NA 1,663 1,766 1,460 NA NA NA 1,663 1,766 1,460	9 33,792 28,242	28,442	31,457 27,737
7,174 7,617 8,757 10,165 11,329 11,761 NA NA NA 828 1,051 834 NA NA NA 511 464 401 NA NA NA 184 369 194 781 1,132 1,641 1,570 1,989 1,663 33,176 34,985 35,330 35,861 33,858 32,185 3 NA NA NA 160 198 125 NA NA NA 160 2,022 2,903 3,395 3,100 2,829 19,808 20,710 22,088 22,783 22,804 23,475 3 NA			
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NA NA NA 47 106 119 NA NA NA 184 369 194 781 1,132 1,641 1,570 1,989 1,663 33,176 34,985 35,330 35,861 33,858 32,185 (NA NA NA 163 198 125 NA NA NA 148 249 120 1,990 2,022 2,903 3,395 3,100 2,829 19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA NA 1,380 1,635 1,453 NA NA NA NA 676 620 609	388		
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781 1,132 1,641 1,570 1,989 1,663 Blacks Blacks Blacks 1,663 1,663 33,176 34,985 35,330 35,861 33,858 32,185 3 NA NA 1,653 1,766 1,460 1,25 1,26 1,460 NA NA 1,653 1,766 1,460 1,25 1,26 1,26 1,26 1,26 1,26 1,26 1,25 3,87 1,20 <th< th=""><td>146</td><td></td><td></td></th<>	146		
## Blacks ## 33,176	9 1,496 1,311	1,358	,258 1,387
33,176 34,985 35,330 35,861 33,858 32,185 32,18			
NA NA NA 1,653 1,766 1,460 NA NA NA 160 198 125 NA NA NA 938 961 828 NA NA NA 407 358 387 1,990 2,022 2,903 3,395 3,100 2,829 19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA NA 1,380 1,635 1,453 NA NA NA NA 676 620 609	37,854 3	41,260 4	4
NA NA NA 160 198 125 NA NA NA 938 961 828 NA NA NA 407 358 387 NA NA NA 148 249 120 1,990 2,022 2,903 3,395 3,100 2,829 19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA 1,380 1,635 1,453 NA NA NA 676 620 609	1,631	1,963	2
NA NA NA 938 961 828 NA NA NA 407 358 387 NA NA NA 148 249 120 1,990 2,022 2,903 3,395 3,100 2,829 19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA 1,380 1,635 1,453 NA NA NA NA 676 620 609	149	178	
NA NA NA 407 358 387 NA NA NA 148 249 120 1,990 2,022 2,903 3,395 3,100 2,829 Hispanics 19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA 1,380 1,635 1,453 NA NA NA 676 620 609	921 1,	1,004	_
1,990 2,022 2,903 3,395 3,100 2,829 1,990 2,022 2,903 3,395 3,100 2,829 Hispanics Hispanics 19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA 1,380 1,635 1,453 NA NA NA 676 620 609	435		
Hispanics 19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA 1,380 1,635 1,453 NA NA NA 676 620 609	8 126 135	201 2698	1/9 148 3 197 2 932
19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA 1,380 1,635 1,453 NA NA NA S48 281 236 NA NA NA 676 620 609	5000	2,00	
19,808 20,710 22,088 22,783 22,804 23,475 2 NA NA NA 1,380 1,635 1,453 NA NA NA 248 281 236 NA NA NA 676 620 609			
NA NA 1,380 1,635 1,453 NA NA 248 281 236 NA NA NA 676 620 609	29,019	33,015 3	(,)
. NA NA 248 281 236 . NA NA NA 676 620 609	1,463	2,152	.,
NA NA 676 620 609	232	300	
	229	1,086	1,074 1,131
	401	613	
NA NA 126 369 176	153	153	
Engineering technology	8 2,411 2,317	2,398	2,478 2,687

Appendix table 2-19. Earned associate degrees, by field and race/ethnicity: 1977-95

Field	1977	1979	1981	1985	1987	1989	1990	1991	1992	1993	1994	1995
				Nativ	Native Americans	SI						
All degrees	2,499	2,336	2,584	2,953	3,049	3,102	3,290	3,772	3,874	4,213	4,879	5,352
Science and engineering	Ϋ́Z	Ϋ́	Ϋ́	163	195	182	202	257	247	315	419	410
Natural sciences ^a	ΑN	Ϋ́Z	Ϋ́	45	49	44	38	99	28	73	125	123
Math and computer sciences	ΑN	Ϋ́	Ϋ́	26	49	29	84	91	69	116	116	124
Social sciences ^b	ΑN	Ϋ́Z	Ϋ́	51	70	29	89	79	106	118	160	142
Engineering	ΑN	Ϋ́Z	Ϋ́	1	27	12	12	21	14	ω	18	21
Engineering technology	204	191	285	267	219	257	168	232	175	210	263	260
				For	Foreign citizens							
All degrees	3,331	4,554	6,645	6,426	4,485	5,969	5,937	6,977	8,027	9,024	10,169	9,911
Science and engineering	Ϋ́Z	Ϋ́	Ϋ́	616	408	461	362	368	520	637	707	707
Natural sciences ^a	ΑN	Ϋ́	Ϋ́	74	81	97	75	73	109	138	157	177
Math and computer sciences	ΑN	ΥZ	Ϋ́	313	177	205	169	171	251	284	282	298
Social sciences ^b	Ϋ́Z	Ϋ́	Ϋ́	73	30	92	48	26	80	137	179	156
Engineering	Ϋ́Z	Ϋ́	Ϋ́	156	120	83	70	89	80	78	88	92
Engineering technology	393	585	1,055	089	575	533	467	526	504	380	414	412

NA = not available

NOTES: Data on associate degrees are not available for broad science and engineering fields before 1983. Data by racial/ethnic group were collected on a biennial schedule until 1990. Data by racial/ethnic group are collected by broad field of study only; therefore, these data cannot be adjusted to the exact field taxonomies used by the National Science Foundation.

*Natural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

bSocial sciences include psychology, sociology, and other social sciences.

SOURCES: National Center for Education Statistics, Earned Degrees and Completion Surveys (Washington, DC: 1995), unpublished tabulations; and National Science Foundation, Science Resources Studies Division, unpublished tabulations.

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Science & Engineering Indicators – 1998

Appendix table 2-20. Earned bachelor's degrees, by field and sex: 1975-95

Field	1975	1977	1979	1981	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						All baci	helor's deg	ree recipie	urts								
All degrees	931,663	928,228	931,340	946,877	980,679	986,345	-	,000,204 1,	٦,	,006,033 1	,030,171 1	,062,151	,	-	,179,278 1	183,141 1,	174,436
Science and engineering	313,555	303,798	303,162	306,792	317,875	324,483	332,422	335,460	331,526	322,482	322,821	329,094	337,675	355,265	366,035	373,261	378,148
Natural sciences	87,199	93,179	90,120	84,062	79,315	76,475		72,499	68,724	64,734	62,860	62,652			77,312	83,791	90,845
Physical	16,001	16,937	17,257	17,446	16,197	15,831		15,784	15,464	14,255	14,148	13,425			14,188	14,655	14,897
Earth/atm/ocean	4,877	5,653	6,082	6,694	7,298	7,925		9/0′9	4,689	3,554	3,181	2,776			3,503	3,868	4,478
Biological & agricultural	66,321	70,589	66,781	59,922	55,820	52,719		50,639	48,571	46,925	45,531	46,451			59,621	65,268	71,470
Math/computer sciences	23,385	20,729	20,670	26,406	37,239	45,777		58,583	56,442	20,877	46,277	42,369			39,433	39,185	38,620
Mathematics	18,346	14,303	11,901	11,173	12,557	13,342		16,388	16,515	15,981	15,314	14,674			14,853	14,632	13,851
Computer sciences	5,039	6,426	8,769	15,233	24,682	32,435		42,195	39,927	34,896	30,963	27,695			24,580	24,553	24,769
Social and behavioral sciences	163,147	148,533	138,903	132,607	128,651	126,078		127,558	131,935	136,717	146,737	159,368			186,585	187,273	185,312
Psychology	51,436	47,794	43,012	41,364	40,825	40,375		40,937	43,195	45,378	48,954	54,018			67,251	69,768	72,601
Social sciences	111,711	100,739	95,891	91,243	87,826	85,703		86,621	88,740	91,339	97,783	105,350			119,334	117,505	112,711
Engineering	39,824	41,357	53,469	63,717	72,670	76,153		76,820	74,425	70,154	66,947	64,705			62,705	63,012	63,371
Chemical engineering	3,420	3,986	6,442	7,639	8,550	9,192		7,411	6,114	4,654	4,187	3,834			4,899	5,636	6,391
Civil engineering	8,289	8,898	10,583	11,331	10,747	10,351		9,223	8,746	8,131	8,015	7,992			9,788	10,603	11,329
Electrical engineering	10,246	10,018	12,440	15,040	19,205	21,541		26,112	26,791	25,942	24,318	2 3,015			19,598	18,241	17,579
Industrial engineering	2,583	2,264	2,804	3,878	3,824	4,020		4,255	4,313	4,259	4,121	4,041			3,584	3,453	3,519
Mechanical engineering	7,089	7,927	10,360	13,573	16,031	17,040		16,586	15,723	15,331	15,217	14,693			14,708	15,297	15,141
Other engineering	8,197	8,264	10,840	12,256	14,313	14,009		13,233	12,738	11,837	11,089	11,130			10,128	9,782	9,412
Engineering technology	8,589	9,864	10,906	13,567	18,663	20,225		20,928	20,577	20,447	20,098	19,150			17,022	16,703	16,607
							Male	Š									
All degrees	508,424	499,121	481,394	474,336	483,395	486,750	486,660	490,143	485,003	481,236	487,566	495,867	508,952	525,395	537,536	537,061	531,146
Science and engineering	210,741	198,805	193,247	190,977	194,538	199,262	203,464	204,771	199,981	191,549	189,338	189,082	189,328	195,779	200,315	202,284	202,217
Natural sciences	63,977	65,378	60,047	53,430	48,379	46,482	45,447	43,405	40,589	36,930	36,009	35,157	36,206	38,939	42,316	45,600	48,474
Physical	12,990	13,560	13,358	13,137	11,586	11,175	11,434	11,088	10,792	9,673	9,777	9,106	9,253	9,289	9,424	9,588	9,605
Earth/atm/ocean	4,050	4,479	4,695	5,028	5,450	5,991	5,715	4,722	3,629	2,707	2,380	2,001	1,946	2,177	2,453	2,665	2,954
Biological & agricultural	46,937	47,339	41,994	35,265	31,343	29,316	28,298	27,595	26,168	24,550	23,852	24,050	25,007	27,473	30,439	33,347	35,915
Math/computer sciences	14,729	13,241	13,249	16,672	22,749	27,797	32,921	35,841	34,871	32,112	29,682	27,184	25,700	25,693	25,483	25,397	25,066
Mathematics	10,646	8,354	6,943	6,392	7,059	7,428	8,231	8,772	8,833	8,569	8,264	7,863	7,804	7,945	7,854	7,864	7,360
Computer sciences	4,083	4,887	908'9	10,280	15,690	20,369	24,690	27,069	26,038	23,543	21,418	19,321	17,896	17,748	17,629	17,533	17,706
Social and behavioral sciences	93,056	80,873	71,363	64,221	60,392	29,529	58,770	59,843	61,500	63,132	888'99	72,009	74,900	78,842	79,792	78,678	76,256
Psychology	24,333	20,692	16,649	14,447	13,228	12,949	12,815	12,691	13,399	13,584	14,291	15,399	16,155	17,130	18,029	18,749	19,638
Social sciences	68,723	60,181	54,714	49,774	47,164	46,610	45,955	47,152	48,101	49,548	52,597	56,610	58,745	61,712	61,763	59,929	56,618
Engineering	38,979	39,313	48,588	56,654	63,018	65,424	66,326	65,682	63,021	59,375	56,759	54,732	52,522	52,305	52,724	52,609	52,421
Chemical engineering	3,273	3,534	5,387	6,274	6,761	7,115	6,848	5,805	4,574	3,522	3,017	2,745	2,564	2,854	3,335	3,953	4,367
Civil engineering	8,116	8,413	9,534	10,100	9,263	8,928	8,388	7,994	7,550	096'9	6,841	6,730	6,803	7,395	8,009	8,619	9,031
Electrical engineering	10,116	9,750	11,781	13,940	17,283	19,252	20,936	22,885	23,227	22,418	21,130	20,148	18,757	17,801	17,339	15,990	15,409
Industrial engineering	2,524	2,115	2,376	3,111	2,824	2,949	2,842	2,974	2,929	3,014	2,860	2,835	2,723	2,890	2,547	2,439	2,493
Mechanical engineering	7,005	7,685	9,740	12,422	14,546	15,228	15,399	14,876	13,996	13,567	13,537	12,978	12,673	12,791	13,076	13,554	13,441
Other engineering	7,945	7,816	9,770	10,807	12,341	11,952	11,913	11,148	10,745	9,894	9,374	9,296	9,002	8,574	8,418	8,054	7,680
Engineering technology	8,054	9,173	9,942	12,032	16,529	18,052	18,278	18,734	18,429	18,337	17,999	17,113	16,329	15,314	15,114	14,877	14,704
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Appendix table 2-20. Earned bachelor's degrees, by field and sex: 1975-95

Field	1975	1977	1979	1981	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
							Fema	səlı									
All degrees	423,239	429,107	449,946	472,541	497,284	499,595	504,217	510,061	518,529	524,797	542,605	566,284	599,045	624,677	641,742	646,080	643,290
Science and engineering	102,814	104,993	109,915	115,815	123,337	125,221	128,958	130,689	131,545	130,933	133,483	140,012	148,347	159,486	165,720	170,977	175,931
Natural sciences	23,222	27,801	30,073	30,632	30,936	29,993	29,982	29,094	28,135	27,804	26,851	27,495	28,983	32,330	34,996	38,191	42,371
Physical	3,011	3,377	3,899	4,309	4,611	4,656	4,836	4,696	4,672	4,582	4,371	4,319	4,425	4,586	4,764	2,067	5,292
Earth/atm/ocean	827	1,174	1,387	1,666	1,848	1,934	1,861	1,354	1,060	847	801	775	782	1,024	1,050	1,203	1,524
Biological & agricultural	19,384	23,250	24,787	24,657	24,477	23,403	23,285	23,044	22,403	22,375	21,679	22,401	23,776	26,720	29,182	31,921	35,555
Math/computer sciences	8,656	7,488	7,421	9,734	14,490	17,980	21,467	22,742	21,571	18,765	16,595	15,185	14,494	14,196	13,950	13,788	13,554
Mathematics	7,700	5,949	4,958	4,781	5,498	5,914	7,036	7,616	7,682	7,412	7,050	6,811	6,980	6,986	6,999	6,768	6,491
Computer sciences	926	1,539	2,463	4,953	8,992	12,066	14,431	15,126	13,889	11,353	9,545	8,374	7,514	7,210	6,951	7,020	7,063
Social and behavioral sciences	70,091	67,660	67,540	68,386	68,259	66,519	66,263	67,715	70,435	73,585	79,849	87,359	95,205	103,324	106,793	108,595	109,056
Psychology	27,103	27,102	26,363	26,917	27,597	27,426	27,422	28,246	29,796	31,794	34,663	38,619	42,738	46,903	49,222	51,019	52,963
Social sciences	42,988	40,558	41,177	41,469	40,662	39,093	38,841	39,469	40,639	41,791	45,186	48,740	52,467	56,421	57,571	57,576	56,093
Engineering	845	2,044	4,881	7,063	9,652	10,729	11,246	11,138	11,404	10,779	10,188	9,973	9,665	9,636	9,981	10,403	10,950
Chemical engineering	147	452	1,055	1,365	1,789	2,077	2,093	1,606	1,540	1,132	1,170	1,089	1,164	1,269	1,564	1,683	2,024
Civil engineering	173	485	1,049	1,231	1,484	1,423	1,342	1,229	1,196	1,171	1,174	1,262	1,280	1,525	1,779	1,984	2,298
Electrical engineering	130	268	629	1,100	1,922	2,289	2,732	3,227	3,564	3,524	3,188	2,867	2,763	2,455	2,259	2,251	2,170
Industrial engineering	29	149	428	292	1,000	1,071	1,167	1,281	1,384	1,245	1,261	1,206	1,097	1,139	1,037	1,014	1,026
Mechanical engineering	8	242	620	1,151	1,485	1,812	1,801	1,710	1,727	1,764	1,680	1,715	1,590	1,561	1,632	1,743	1,700
Other engineering	252	448	1,070	1,449	1,972	2,057	2,111	2,085	1,993	1,943	1,715	1,834	1,771	1,687	1,710	1,728	1,732
Engineering technology	535	691	964	1,533	2,134	2,173	2,255	2,194	2,148	2,110	2,099	2,037	1,965	1,804	1,908	1,826	1,903

SOURCES: National Center for Education Statistics, Earned Degrees and Completion Surveys (Washington, DC: 1995), unpublished tabulations; and National Science Foundation, Science Resources Studies Division, unpublished tabulations.

See figures 2-11 and 2-12 and text table 2-5.

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Appendix table 2-21. Earned bachelor's degrees, by field, race/ethnicity, and citizenship: 1977-95

Field and race/ethnicity	1977	1979	1981	1985	1987	1989	1991	1993	1994	1995
				Total						
All degrees	928,228	931,340	946,877	990,877		1,030,171		1,179,278		1,174,436
Science and engineering	337,834	334,632	337,739	342,970	343,070	337,431	356,785	388,435	395,380	399,809
Natural sciences ^a	98,342	96,186	90,254	75,670	68,929	63,073	65,401	77,395	83,903	91,026
Math and computer sciences	20,729	20,670	26,406	54,388	56,442	46,277	40,194	39,347	38,889	38,421
Social sciences ^b	169,086	154,976	145,684	135,341	143,276	161,134	189,004	209,023	209,626	207,032
Engineering	49,677	62,800	75,395	77,571	74,423	66,947	62,186	62,670	62,962	63,330
Engineering technology	NA	NA U.S	NA	20,533	20,577	20,098	18,294	16,987	16,654	16,542
All dames as	010.005		citizens a				1.050.010	1 100 070	1 100 000	1 110 510
All degrees	910,835	911,637	923,906	950,118	948,563	•	1,052,610	1,122,276		1,110,512
Science and engineering	329,351	324,750	324,724	325,172	319,963	317,950	335,424	366,357	372,858	375,745
Natural sciences ^a	96,268	94,101	88,001	72,860	65,632	60,423	62,117	73,571	80,096	86,688
Math and computer sciences	20,138	19,926	25,172	50,904	51,449	42,245	36,549	35,864	35,283	34,709
Social sciences ^b	166,852	152,720	143,165	131,499	135,722	154,321	180,423	199,948	200,256	197,120
Engineering	46,093	58,003	68,386	69,909	67,160	60,961	56,335	56,974	57,223	57,228
Engineering technology	NA	NA	NA	19,120	19,359	18,942	17,080	16,109	16,161	15,992
White, all degrees	807,857	802,665	807,509	826,356	819,477	840,326	892,363	931,603	918,124	892,785
Science and engineering	292,802	287,126	284,166	281,394	272,090	266,862	278,190	297,171	297,616	294,773
Natural sciences ^a	88,308	85,403	78,778	63,592	55,898	50,580	51,113	59,577	64,291	68,700
Math and computer sciences	18,110	17,633	22,013	43,484	42,446	33,998	28,998	27,824	26,905	25,875
Social sciences ^b	144,312	131,439	122,519	113,326	117,255	132,203	152,917	164,917	161,733	156,472
Engineering	42,072	52,651	60,856	60,992	56,491	50,081	45,162	44,853	44,687	43,726
Engineering technology	NA	NA	NA	16,673	16,541	16,156	14,279	13,245	12,909	12,616
Asian, all degrees	13,907	15,542	18,908	25,562	31,921	37,573	41,725	50,587	54,675	59,295
Science and engineering	6,203	7,171	9,145	13,323	16,934	19,138	20,552	24,504	26,420	29,128
Natural sciences ^a	1,935	2,227	2,406	2,880	3,641	3,973	4,670	6,364	7,228	8,677
Math and computer sciences	479	587	1,061	2,929	3,489	3,287	2,925	3,160	3,173	3,330
Social sciences ^b	2,578	2,499	2,612	3,032	4,214	5,803	6,737	8,573	9,503	10,336
Engineering	1,211	1,858	3,066	4,482	5,590	6,075	6,220	6,407	6,516	6,785
Engineering technology	0	0	0	542	807	839	768	768	720	727
Black, all degrees	58,700	60,301	60,729	57,563	55,103	56,837	65,009	76,667	82,316	85,287
Science and engineering	19,552	18,827	18,895	17,040	17,230	17,385	19,987	24,421	26,289	27,528
Natural sciences ^a	3,416	3,541	3,561	3,096	2,870	2,756	3,026	3,794	4,169	4,528
Math and computer sciences	1,073	1,159	1,371	2,913	3,654	3,249	2,808	3,178	3,390	3,493
Social sciences ^b	13,678	12,352	11,514	8,992	8,391	9,313	11,924	14,872	16,071	16,662
Engineering	1,385	1,775	2,449	2,039	2,315	2,067	2,229	2,577	2,659	2,845
Engineering technology	0	0	0	1,277	1,269	1,208	1,227	1,132	1,249	1,319
Hispanic, all degrees	27,043	29,719	33,167	36,391	38,196	41,361	49,027	57,845	62,683	66,691
Science and engineering	9,628	10,432	11,312	12,031	12,419	13,327	15,351	18,442	20,529	22,190
Natural sciences ^a	2,271	2,634	2,958	2,979	2,964	2,849	3,010	3,468	3,970	4,276
Math and computer sciences	435	495	688	1,380	1,696	1,568	1,695	1,566	1,678	1,843
Social sciences ^b	5,632	5,748	5,846	5,485	5,205	6,349	8,080	10,447	11,738	12,420
Engineering	1,290	1,555	1,820	2,187	2,554	2,561	2,566	2,961	3,143	3,651
Engineering technology	0	0	0	525	664	634	731	853	813	883
Native American, all degrees	3,328	3,410	3,593	4,246	3,866	3,967	4,486	5,574	6,064	6,454
Science and engineering	1,166	1,194	1,206	1,384	1,290	1,238	1,344	1,819	2,004	2,126
Natural sciences ^a	338	296	298	313	259	265	298	368	438	507
Math and computer sciences	41	52	39	198	164	143	123	136	137	168
Social sciences ^b	652	682	674	664	657	653	765	1,139	1,211	1,230
Engineering	135	164	195	209	210	177	158	176	218	221
Engineering technology	0	0	0	103	78	105	75	111	98	115

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Appendix table 2-21. Earned bachelor's degrees, by field, race/ethnicity, and citizenship: 1977-95

Field and race/ethnicity	1977	1979	1981	1985	1987	1989	1991	1993	1994	1995
			For	eign citize	ns					
All degrees	15,744	17,853	22,631	29,258	28,592	26,457	29,657	32,371	34,227	37,012
Science and engineering	8,297	9,798	12,966	14,071	13,677	12,323	12,724	13,802	13,929	14,754
Natural sciences ^a	2,042	2,061	2,251	2,132	1,786	1,744	1,941	2,330	2,114	2,262
Math and computer sciences	583	741	1,233	2,879	3,233	2,678	2,615	2,756	2,835	2,888
Social sciences ^b	2,098	2,232	2,519	2,870	2,769	2,829	3,586	4,211	4,440	4,794
Engineering	3,574	4,764	6,963	6,190	5,889	5,072	4,582	4,505	4,540	4,810
Engineering technology	NA	NA	NA	1,277	986	659	712	441	493	550

NA = not available

NOTES: Data by racial/ethnic group were collected on a biennial schedule until 1990 and annually thereafter. Data by racial/ethnic group are collected by broad fields of study only; therefore, these data cannot be adjusted to the exact field taxonomies used by the National Science Foundation.

SOURCE: National Science Foundation, Science Resources Studies Division, Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1977-94, NSF 96–329 (Arlington, VA: 1996).

See text table 2-5.

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^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

^bSocial sciences include psychology, sociology, and other social sciences.

Appendix table 2-22. Semesters of postsecondary math courses taken, by type of college and major: 1991-94 (Percentages)

		N	Number of math	n courses tak	cen	
Postsecondary education/major	0	1 to 2	3 to 4	5 +	Median	N
Total	16	47	28	9	2	1,530
Some community college education	34	50	14	2	1	352
Some college/university education	16	59	24	2	2	316
Associate degree	26	46	21	7	2	121
Bachelor's degree	7	41	37	15	3	741
Students with	some cor	nmunity colle	ge education			
Science, math, engineering, or other technical	15	35	44	6	2	48
Health	21	56	19	4	1	52
Social science	41	47	12	0	1	17
Education	17	53	27	3	2	30
Other major	18	62	15	5	2	137
Not reported/no major	50	42	7	1	0	191
Students with	some co	llege/universit	y education			
Science, math, engineering, or other technical	3	40	44	13	3	40
Health	11	59	27	3	2	37
Social science	6	75	16	3	2	32
Education	23	54	23	0	2	22
Other major	12	60	27	1	2	102
Not reported/no major	29	61	9	0	1	85
Students v	vith bach	elor's degree o	or higher			
Science	1	39	45	15	3	78
Math, engineering, or other technical	2	8	37	53	5	87
Health	7	44	36	13	2	62
Social science	7	52	33	8	2	121
Education	5	34	51	10	3	88
Other major	9	48	33	10	2	298

NOTES: Only respondents enrolled in or graduated from a community college, college, or university degree program are included in this analysis. Respondents who are not in any educational program, are still in high school or a GED program, or are in a vocational or trade school program are not included. The four categories of postsecondary education are (1) some community college education (but no degree), (2) some college or university education (but no degree), (3) associate degree, and (4) bachelor's degree or higher. Postsecondary education data from the Longitudinal Study of American Youth were collected during years four (1991), five (1992), and seven (1994) of the study. Those data collection points represent the first, second, and fourth postsecondary years. Thus, a student who graduated from high school in the usual time sequence could have completed a baccalaureate at the time of the last data collection point.

SOURCE: J.D. Miller, Longitudinal Study of American Youth, special tabulations, 1997.

Appendix table 2-23. Semesters of postsecondary science courses taken, by type of college and major: 1991-94 (Percentages)

		Numb	er of science c	ourses taker	1	
Postsecondary education/major	0	1 to 2	3 to 4	5 +	Median	N
Total	25	31	23	21	2	1,529
Some community college education	55	27	13	5	0	352
Some college/university education	30	40	19	11	1	315
Associate degree	39	30	18	13	2	120
Bachelor's degree	6	31	30	33	3	742
Students with	some con	nmunity colle	ge education			
Science, math, engineering, or other technical	30	26	33	11	2	47
Health	16	33	20	31	3	51
Social science	35	29	24	12	2	17
Education	30	43	24	3	2	33
Other major	58	27	13	2	0	137
Not reported/no major	66	25	6	3	0	189
Students with	some co	lege/universit	y education			
Science, math, engineering, or other technical	15	28	32	25	3	40
Health	8	29	24	39	4	38
Social science	24	38	38	0	2	29
Education	29	47	14	10	2	21
Other major	27	53	15	5	1	101
Not reported/no major	51	33	11	5	0	87
Students v	vith bache	elor's degree o	or higher			
Science	0	3	5	92	10	79
Math, engineering, or other technical	5	17	30	48	4	86
Health	0	6	15	79	7	62
Social science	7	33	37	23	3	120
Education	2	29	43	26	3	89
Other major	8	47	33	12	2	298

NOTES: Only respondents enrolled in or graduated from a community college, college, or university degree program are included in this analysis. Respondents who are not in any educational program, are still in high school or a GED program, or are in a vocational or trade school program are not included. The four categories of postsecondary education are (1) some community college education (but no degree), (2) some college or university education (but no degree), (3) associate degree, and (4) bachelor's degree or higher. Postsecondary education data from the Longitudinal Study of American Youth were collected during years four (1991), five (1992), and seven (1994) of the study. Those data collection points represent the first, second, and fourth postsecondary years. Thus, a student who graduated from high school in the usual time sequence could have completed a baccalaureate at the time of the last data collection point.

SOURCE: J.D. Miller, Longitudinal Study of American Youth, special tabulations, 1997.

Appendix table 2-24. Graduate enrollment in science and engineering, by field and sex: 1975-95

Field	1975	1977	1979	1981	1983	1985	1987	1988	1989	1990	1991	1992	1993	1994	1995
						Total									
Science & engineering	303,190	311,816	319,171	332,086	347,065	358,126	373,355	375,287	382,769	397,159	412,708	430,797	436,233	431,758	423,922
Natural sciences ^a	95,489	101,221	100,871	100,617	102,979	104,074	104,963	105,529	107,301	109,364	112,474	116,699	119,489	120,833	120,451
Math & computer sciences	25,307	25,160	25,160 26,721	32,318	40,691	47,332	50,559	51,304	51,729	54,031	54,562	56,675	56,298	53,857	52,018
Social sciences ^b	119,851	114,716	112,652	121,462	116,538	110,515	111,412	113,880	115,625	119,696	126,139	132,096	139,388	143,565	144,008
Engineering	68,271	68,685	71,728	79,555	91,119	95,991	103,953	102,829	104,043	107,625	113,576	118,035	116,881	113,060	107,529
						Males									
Science & engineering	Ϋ́	233,862	229,860	232,209	240,525	247,464	256,158	254,011	256,861	263,407	271,853	280,465	279,476	272,420	263,058
Natural sciences ^a	0	76,073	72,945	70,721	70,711	70,745	70,685	69,869	70,263	70,800	71,753	73,754	74,086	73,878	72,591
Math & computer sciences	0	19,482	20,376	23,628	28,877	34,417	36,948	37,334	37,756	39,633	39,994	41,659	41,188	39,170	37,582
Social sciences ^b	0	73,322	70,687	66,051	59,622	57,391	52,535	57,103	58,399	60,021	62,245	64,250	65,013	64,366	63,508
Engineering	Ν	64,985	65,852	71,809	81,312	84,911	90,990	89,705	90,443	92,953	97,861	100,802	99,189	92,006	89,377
						Females									
Science & engineering	Ν	77,954	89,311	99,877	106,540	110,662	117,197	121,276	125,908	133,752	140,855	150,332	156,757	159,338	160,864
Natural sciences ^a	0	25,148	27,926	29,896	32,268	33,329	34,278	35,660	37,038	38,564	40,721	42,945	45,403	46,955	47,860
Math & computer sciences	0	5,678	6,345	8,690	11,814	12,915	13,611	13,970	13,973	14,398	14,568	15,016	15,110	14,687	14,436
Social sciences ^b	0	43,428	49,164	53,545	52,651	53,338	56,345	58,522	61,297	66,118	69,851	75,138	78,552	79,642	80,416
Engineering	Ν	3,700	5,876	7,746	9,807	11,080	12,963	13,124	13,600	14,672	15,715	17,233	17,692	18,054	18,152

NA = not available

NOTE: For detailed statistical tables on graduate enrollments, see SRS home page <<http://www.nsf.gov/sbe/srs/stats.htm>>, Fall 1995 Supplementary Data Releases: Trends in Graduate Enrollment, 1975-1995.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

^ьSocial sciences include psychology, sociology, and other social sciences.

SOURCE: National Science Foundation, Science Resources Studies Division, Graduate Students and Postdoctorates in Science and Engineering, Fall 1995, NSF 97-312 (Arlington, VA: 1997).

See figures 2-13 and 2-14.

Appendix table 2-25. Graduate enrollment in science and engineering, by field, race/ethnicity, and citizenship: 1983-95

	1000	7007	1005	1006	1007	1000	1000	1000	1001	1000	1000	1007	1005
rieid and race/eumicity	1903	1904	200	1900	1961	1900	8081	0881	1881	1881	1883	1994	C881
					Total	al							
Science & engineering Natural sciences ^a	347,014 102,968	349,875 103,547	358,201 103,990	368,212 105,541	373,425 104,974	375,287 105,529	382,769 107,301	397,159 109,364	412,708 112,474	430,797 116,699	436,233 119,489	431,758 120,833	423,922 120,451
Math & computer sciences	40,713	42,985	47,341	49,316	50,575	51,304	51,729	54,031	54,562	56,675	56,298 143,565	53,857	52,018 143 924
Engineering	91,097	92,696		101,856	103,937	102,829	104,043	107,625	113,576	118,035	116,881	113,060	107,529
					U.S. cit	citizens							
Total S&E	276,784	277,682	281,388	284,231	284,631	281,672	284,686	294,339	304,073	321,281	330,447	329,391	325,135
Natural sciences ^a	84,700	84,712	83,663	82,854	80,562	79,431	79,242	79,521	81,148	84,893	88,164	89,852	90,653
Math & computer sciences	30,306	31,532	34,499	35,448	35,669	35,895	35,352	36,561	36,306	38,043	38,210	36,696	35,484
Social sciences	98, 173 63,605	90,644 64,794	93,978 67,160	96,018 69,911	70,569	96,743 67,603	67,346	69,426	72,233	76,595	77,614	76,065	72,042
White, S&E	224,705	224,705	224,705	224,705	224,705	229,037	229,694	238,492	243,608	253,516	257,009	255,976	246,776
Natural sciences ^a	74,337	74,046	71,971	71,713	69,100	68,737	68,110	68,736	69,472	71,328	72,552	74,134	73,332
Math & computer sciences	23,823	24,040	25,511	26,053	26,806	27,479	26,560	27,897	26,921	27,745	27,373	26,245	24,425
Social sciences	48,582	48,582	48,582	48,582	48,582	52,329	51,493	53,207	54,784 54,784	57,396	57,451	56,031	52,113
Asian, S&E	9,353	10,172	12,000	12,775	14,572	15,188	15,693	17,156	18,139	21,762	24,149	26,457	26,015
Natural sciences ^a	2,378	2,526	2,712	2,761	3,043	3,478	3,604	3,928	4,267	5,035	6,162	6,568	6,740
Math & computer sciences	1,666	1,816	2,491	2,770	3,235	3,438	3,430 2,648	3,710	3,724	4,363	4,592 7.396	5,302	5,227
Engineering	3,406	3,812	1,992 4,805	5,130	5,858	5,910	6,011	6,687	7,116	8,492	8,999	9,801	9,118
Black, S&E	10,903	10,711	10,462	10,470	10,429	11,191	11,775	12,774	13,691	15,449	17,147	17,665	18,366
Natural sciences ^a	1,980	2,000	1,982	1,845	1,817	1,972	2,093	2,184	2,302	2,711	3,042	3,007	3,286
Math & computer sciences	971	960	1,031	1,151	1,210	1,261	1,311	1,496	1,617	1,687	1,903	1,888	1,879
Engineering	1,378	1,445	1,387	1,452	1,416	1,500	1,616	1,786	2,025	2,374	2,559	2,783	2,872
Hispanic, S&E	8,811	8,681	8,613	8,660	8,823	9,098	9,436	10,159	11,045	12,248	13,386	13,284	14,089
Natural sciences ^a	1,919	1,892	2,092	2,118	2,071	2,228	2,386	2,375	2,552	2,726	3,075	2,933	3,200
Math & computer sciences	615 7.836	585	750	723	817 7067	844	847 7406	916	980	7,082	6,503	1,006	090,L
Engineering	1,441	1,491	1,481	1,602	1,730	1,719	1,707	1,886	2,124	2,463	2,694	2,857	2,831
Native American S&E	911	830	736	743	783	918	860	1,054	1,120	1,244	1,312	1,383	1,524
Natural sciences ^a	224	206	167	196	183	216	180	255	251	282	318	336	403
Math & computer sciences	53	71	79	52 365	76	71	74	64 683	62	66 989	100	7.96	125 765
Engineering	180	192	122	130	123	143	122	152	185	177	211	242	231
Unknown, S&E	22,101	24,179	25,825	23,961	21,160	16,240	17,228	14,704	16,470	17,062	17,444	14,626	18,365
Natural sciences ^a	3,862	4,042	4,819	4,221	4,348 3,505	2,800	2,869	2,043	2,304	2,811	3,015	2,874	3,692
Social sciences	6.443	7.459	7,145	6.354	5.646	4,636	4.832	4.475	5,002	5,491	5,601	5.225	7.028
Engineering	8,618	8,618	9,224	8,687	7,641	6,002	6,397	5,708	5,999	5,693	5,700	4,351	4,877
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Appendix table 2-25. Graduate enrollment in science and engineering, by field, race/ethnicity, and citizenship: 1983-95

:::::::::::::::::::::::::::::::::::::::			1000		1								100
Field and race/ethnicity	1983	1983 1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
					Foreign citizens	itizens							
Total S&E	70,230	72,193	76,813	83,981	88,794	93,615	98,083	102,820	108,635	109,516	105,786	102,367	98,787
Natural sciences ^a	18,268	18,835	20,327	22,687	24,412	26,098	28,059	29,843	31,326	31,806	31,325	30,981	29,798
Math & computer sciences	10,407	11,453	12,842	13,868	14,906	15,409	16,377	17,470	18,256	18,632	18,088	17,161	16,534
Social sciences ^b	14,063	14,003	14,830	15,481	16,108	16,882	16,950	17,308	17,710	17,638	17,106	17,230	16,968
Engineering	27,492	27,902	28,822	31,945	33,368	35,226	36,697	38,199	41,343	41,440	39,267	36,995	35,487

NOTE: For detailed statistical tables on graduate enrollments, see SRS home page <<http://www.nsf.gov/sbe/srs/stats.htm>>, Fall 1995 Supplementary Data Releases: Trends in Graduate Enrollment, 1975-1995.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

bSocial sciences include psychology, sociology, and other social sciences.

SOURCE: National Science Foundation, Science Resources Studies Division, Graduate Students and Postdoctorates in Science and Engineering Fall 1995, NSF 97-312 (Arlington, VA: 1997).

See figure 2-14.

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Appendix table 2-26. Doctoral degrees awarded in science and engineering in selected Asian countries: 1975-95

Country	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
									Natura	al sciences	cesa										
Total	2,162	2,399	2,706	2,863	3,120	3,268	3,390	3,523	3,665		4,017	3,992	4,015	4,326				4,547	5,141	5,752	6,304
China	Ϋ́	Ϋ́	Ϋ́	Ž	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ν Α	Ϋ́	88	27	25	165	141	209	252	304	479	755	1,191
India	1,484	1,651	1,837	2,044	2,261	2,385	2,516	2,654	2,800		2,892	2,922	2,814	3,038			_	2,950	3,386	3,505	3,505
Japan	9/9	717	843	782	814	822	791	762	774		860	820	837	881		_	٠.	1,009	934	1,081	1,135
S. Korea	Ν	59	22	30	41	22	75	102	83		212	201	277	207	٠.	_		202	244	296	358
Taiwan	7	7	4	7	4	9	ω	2	∞		20	22	35	35				82	26	115	115
								Mathem	atics an	d comb	outer sci	ences									
Total	0	0	0	0	-	-	-	က	4	2	27	23	45	162	201	188	226	249	169	194	224
China	¥	¥	Ν	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ϋ́	ΑN	Ž	23	10	31	22	78	88	92	101	0	0	Ϋ́
India	Ϋ́	¥	Ϋ́	Ϋ́	Ϋ́	Ϋ́	¥	Ν	Α	¥	Ϋ́	Υ	Ϋ́	¥	ΑN	ΑN	Ϋ́	Υ	Ϋ́	Υ	Ϋ́
Japan	Ϋ́	¥	Α	Υ	Α	Ϋ́	Ϋ́	ΑN	Α	¥	Ϋ́	Υ	Α	¥	ΑN	Α	Ϋ́	Υ	Α	Ϋ́	Ϋ́
S. Korea	¥	Ϋ́	Ν	Ϋ́	Ϋ́	N	Ϋ́	Ϋ́	ΑN	Ϋ́	Ž	Ν	Ν	73	105	75	66	106	124	145	169
Taiwan	0	0	0	0	-	-	_	က	4	7	4	13	14	4	18	54	35	42	45	49	22
									Ag	ricultur	9										
Total	674	870	934	912	962	1,098	1,153	1,185	1,240	1,404	1,372	1,355	1,444	1,696	1,689	1,629	1,814	1,797	1,742	1,911	2,048
China	¥	¥	Ν	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Α	Ž	-	0	œ	22	26	20	37	89	94	131	182
India	289	328	372	422	480	517	558	601	648	869	575	929	583	712	688	703	715	715	611	572	572
Japan	381	490	518	442	430	527	529	521	515	614	269	646	715	746	734	719	870	824	816	952	1,008
S. Korea	Ϋ́	48	40	43	45	48	25	22	90	77	88	105	110	155	175	154	156	151	172	196	223
Taiwan	4	4	4	2	7	2	15	80	17	15	9	28	28	28	36	33	36	33	48	09	63
									Socia	al scienc	gSə:										
Total	91	123	124	113	106	108	111	131	153	152	193	215	273	305	338	369	467	544	265	695	775
China	Ϋ́	Ϋ́	NA	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Α̈́	Ν	Ž	0	-	0	56	23	36	47	61	06	134	198
India	Ν	¥	Ϋ́	Ν	Ϋ́	Ϋ́	Ϋ́	Ν	Ϋ́	¥	Ϋ́	Ν	Ϋ́	¥	Ϋ́	ΑN	Υ	Υ	Ϋ́	Υ	Ϋ́
Japan	8	82	88	88	9/	92	9/	93	26	90	127	136	149	167	177	183	200	243	249	278	301
S. Korea	Ν	31	23	23	24	24	25	22	41	33	20	25	102	06	26	107	189	217	222	227	232
Taiwan	7	7	13	2	9	80	10	13	15	23	16	56	22	22	41	43	31	23	36	26	44
									Ēnć	gineerin	g										
Total	1,130	1,242	1,195	1,323	1,408	1,417	1,494	1,566	1,590	1,634	2,239	2,447	2,645	3,212			١	4,630	4,586	5,260	6,327
China	¥	¥	Ν	Ϋ́	Ϋ́	₹	Ϋ́	Ϋ́	Ν	Ž	89	83	127	476				823	1,040	1,313	1,659
India	136	135	135	134	176	179	182	185	189	192	511	209	603	575			_	629	323	348	348
Japan	986	1,079	1,043	1,166	1,195	1,186	1,236	1,278	1,290	1,291	1,404	1,493	1,547	1,717				2,362	2,278	2,501	3,009
S. Korea	Ϋ́	20	14	20	59	42	90	87	26	120	197	273	270	346	415	439	466	552	629	786	938
Taiwan	80	∞	က	က	80	10	15	15	14	31	29	83	86	86			_	264	287	312	373

*Natural sciences here include physical, earth, atmospheric, oceanographic, and biological sciences.

"Social sciences include psychology, sociology, and other social sciences. Japanese social science data also include business administration.

SOURCES: China—National Research Center for Science and Technology for Development, unpublished tabulations, and UNESCO, Statistical Yearbook (Paris: 1996); India—Department of Science and Technology, Research and Development Statistics 1994-95 (New Delhi: 1996); Japan—Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); South Korea—Ministry of Education, Statistical Yearbook of Education (Seoul: 1996); and Taiwan—Ministry of Educational Statistics of the Republic of China (Taipei: 1996).

Science & Engineering Indicators – 1998

Appendix table 2-27. Earned master's degrees, by field and sex: 1975-95

293,651 318,241 302,075 296,798 63,198 67,397 64,226 64,366 14,831 15,360 15,443 14,349 4,298 3,641 3,650 3,366 1,503 1,659 1,777 1,876 9,030 10,060 10,016 9,107 6,637 6,496 6,101 6,787 4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902	290,931 28 67,716 6 14,380 1 3,285 1,959 9,136 8,160 2,839 5,321 26,290 2 8,439 17,851 1 18,886 2 1,545 3,504 4,819 1,432 2,683	Total master's degree recipients 285,462 287,213 289,829 290,53 68,564 70,562 71,831 72,60 14,231 13,972 13,910 13,40 3,544 3,605 3,649 3,57 1,982 2,160 2,234 2,05 8,705 8,207 8,027 7,77 8,939 9,989 11,241 11,80 2,749 2,888 3,171 3,32 6,190 7,101 8,070 8,48 25,249 25,529 25,584 25,532	degree rec 3 289,829 2 71,831 2 13,910	ipients 290,532 72,603	300,091	311,050	324,947	338,498	354,207	370 078		
318,241 302,075 296,798 2 67,397 64,226 64,366 15,369 13,439 3,641 3,650 3,366 3,366 3,366 1,659 1,777 1,876 1,07 1,060 10,016 9,107 6,496 6,101 6,787 6,496 6,101 6,787 2,569 2,569 3,046 2,569 7,798 3,055 4,218 26,779 8,031 8,039 26,779 8,320 8,031 8,039 16,451 16,451 16,012 1,406 1,179 1,276 1,406 1,406 3,428 3,506 3,428 3,788 3,596 3,590 3,902 3,902 3,902	•	<u>-</u>		290,532 72,603	300,091	311,050	324,947	338,498	354,207	270 072		
63,198 67,397 64,226 64,366 14,831 15,360 15,443 14,349 4,298 3,641 3,650 3,366 1,503 1,659 1,777 1,876 9,030 10,060 10,016 9,107 6,637 6,496 6,101 6,787 4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902		<u>.</u>		72,603	70 055			1		010,010		399,428
14,831 15,360 15,443 14,349 4,298 3,641 3,650 3,366 1,503 1,659 1,777 1,876 9,030 10,060 10,016 9,107 6,637 6,496 6,101 6,787 4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,608 3,165 3,428 3,471 3,788 3,596 3,902					7 3,000	76,425	77,788	78,368	81,107	86,425		94,309
4,298 3,641 3,650 3,366 1,503 1,659 1,777 1,876 9,030 10,060 10,016 9,107 6,637 6,496 6,101 6,787 4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				13,400	13,184	13,218	12,928	12,682	13,232	13,474	14,367	14,793
1,503 1,659 1,777 1,876 9,030 10,060 10,016 9,107 6,637 6,496 6,101 6,787 4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				3,574	3,708	3,876	3,805	3,777	3,922	3,965	4,263	4,241
9,030 10,060 10,016 9,107 6,637 6,496 6,101 6,787 4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				2,051	1,920	1,819	1,596	1,499	1,425	1,397	1,418	1,483
6,637 6,496 6,101 6,787 4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				7,775	7,556	7,523	7,527	7,406	7,885	8,112	8,686	690'6
4,338 3,698 3,046 2,569 2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				11,808	12,600	12,829	13,327	12,956	13,320	14,100	14,350	14,495
2,299 2,798 3,055 4,218 26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				3,327	3,434	3,430	3,684	3,632	3,665	3,751	3,804	3,932
26,563 29,529 27,403 26,779 7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				8,481	9,166	9,399	9,643	9,324	9,655	10,349	10,546	10,563
7,104 8,320 8,031 8,039 19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				25,325	25,145	26,635	27,538	28,717	29,537	31,187	33,977	36,391
19,459 21,209 19,372 18,740 15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				8,165	7,925	8,652	9,308	9,802	9,852	10,412	11,572	13,132
15,167 16,012 15,279 16,451 1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				17,160	17,220	17,983	18,230	18,915	19,685	20,775	22,405	23,259
1,078 1,179 1,276 1,406 3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				22,070	22,726	23,743	23,995	24,013	25,018	27,664	28,717	28,630
3,268 3,606 3,165 3,428 3,471 3,788 3,596 3,902				1,386	1,322	1,321	1,205	1,025	1,145	1,220	1,287	1,369
3,471 3,788 3,596 3,902				3,267	3,134	3,296	3,213	3,404	3,755	4,438	4,918	5,168
				6,895	7,455	7,849	8,009	7,942	8,274	8,828	8,870	8,743
Industrial engineering 1,687 1,609 1,502 1,631				1,728	1,816	1,823	1,834	2,039	2,370	2,745	2,882	2,873
. 2,032 2,094 2,012 2,419				3,380	3,513	3,703	3,630	3,680	3,826	4,169	4,277	4,368
Other engineering 3,631 3,736 3,728 3,665				5,414	5,486	5,751	6,104	5,923	5,648	6,264	6,483	6,109
371 505 496 532				883	086	1,135	1,194	1,188	1,278	1,555	1,547	1,577
		_	Aales									
All degrees	145,114 14	43,998 143,71		141,655	145,403	149,399	154,025	156,895	162,299	169,753		179,198
49,410 50,899 46,614 45,505	m	47,033 48,232	2 48,611	48,759	49,820	50,845	51,230	50,441	52,157	55,454	_	58,518
Natural sciences 11,709 11,633 11,223 10,222 8				8,652	8,562	8,383	8,052	7,794	8,118	8,181	8,539	8,730
				2,684	2,817	2,836	2,754	2,703	2,834	2,794	3,030	2,958
1,309 1,433 1,467 1,470				1,531	1,433	1,337	1,218	1,116	1,057	1,006	994	1,032
7,219 6,785 6,061				4,437	4,312	4,210	4,080	3,975	4,227	4,381	4,515	4,740
4,871 4,730 4,469 4,939	5,672			8,011	8,759	8,833	9,176	8,709	9,199	9,773	10,128	10,130
. 2,910 2,398 1,989 1,692				2,026	2,057	2,060	2,208	2,146	2,219	2,219	2,311	2,353
. 1,961 2,332 2,480 3,247				2,985	6,702	6,773	6,968	6,563	6,980	7,554	7,817	7,777
s 18,035 19,222 16,580 15,222				12,796	12,581	12,968	13,276	13,282	13,491	13,930	15,009	15,660
. 4,059 4,316 3,688 3,371				2,838	2,599	2,814	3,025	2,994	2,929	2,928	3,287	3,735
13,976 14,906 12,892 11,851				9,958	9,982	10,154	10,251	10,288	10,562	11,002	11,722	11,925
. 14,795 15,314 14,342 15,122				19,300	19,918	20,661	20,726	20,656	21,349	23,570	24,294	23,998
. 1,051 1,110 1,156 1,230				1,143	1,107	1,092	1,013	852	914	966	1008	1063
3,421 2,951 3,112				2,792	2,721	2,851	2,693	2,864	3,120	3,607	3,965	4,123
. 3,413 3,654 3,453 3,681				6,178	6,642	6,933	7,018	7,008	7,229	7,777	7,721	7,539
. 1,631 1,534 1,374 1,465				1,409	1,492	1,465	1,493	1,603	1,898	2,190	2,346	2,361
2,012 2,039 1,939 2,292				3,133	3,218	3,377	3,276	3,320	3,455	3,769	3,860	3,918
3,527 3,556 3,469 3,342				4,645	4,738	4,943	5,233	5,009	4,733	5,231	5,394	4,994
Engineering technology 281 389 371 380				829	738	892	888	888	971	1,172	1,164	1,136

Appendix table 2-27. Earned master's degrees, by field and sex: 1975-95

Field	1975	1977	1979	1981	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
							Females	les									
All degrees131,536	131,536	150,031	148,303	149,367	145,817	141,464	ı —	145,897	148,877	154,688	161,651	170,922	181,603	191,908	201,220	212,246	220,230
Science and engineering	13,788	16,498	17,612	18,861	20,998	21,531	22,330	23,220	23,844	23,835	25,580	26,558	27,927	28,950	30,971	33,441	35,791
Natural sciences	3,122	3,727	4,220	4,127	4,566	4,718		4,777	4,748	4,622	4,835	4,876	4,888	5,114	5,293	5,828	6,063
Physical	653	099	629	675	685	846		913	890	891	1,040	1,051	1,074	1,088	1,171	1,233	1,283
Earth/atm/ocean	194	226	310	406	444	465		517	520	487	482	378	383	368	391	424	451
Biological & agricultural	2,275	2,841	3,231	3,046	3,437	3,407		3,347	3,338	3,244	3,313	3,447	3,431	3,658	3,731	4,171	4,329
Math/computer sciences	1,766	1,766	1,632	1,848	2,488	2,765		3,528	3,797	3,841	3,996	4,151	4,247	4,121	4,327	4,222	4,365
Mathematics	1,428	1,300	1,057	877	980	954		1,116	1,301	1,377	1,370	1,476	1,486	1,446	1,532	1,493	1,579
Computer sciences	338	466	212	971	1,508	1,811		2,412	2,496	2,464	2,626	2,675	2,761	2,675	2,795	2,729	2,786
Social & behavioral sciences	8,528	10,307	10,823	11,557	12,189	11,948		12,515	12,529	12,564	13,667	14,262	15,435	16,046	17,257	18,968	20,731
Psychology	3,045	4,004	4,343	4,668	5,185	5,093		5,426	5,327	5,326	5,838	6,283	6,808	6,923	7,484	8,285	9,397
Social sciences	5,483	6,303	6,480	6,889	7,004	6,855		7,089	7,202	7,238	7,829	7,979	8,627	9,123	9,773	10,683	11,334
Engineering	372	869	937	1,329	1,755	2,100		2,400	2,770	2,808	3,082	3,269	3,357	3,669	4,094	4,423	4,632
Chemical engineering	27	69	120	176	176	208		240	243	215	229	192	173	231	224	279	306
Civil engineering	107	185	214	316	382	415		373	475	413	445	520	540	635	831	953	1045
Electrical engineering	28	134	143	221	335	438		639	717	813	916	991	934	1,045	1,051	1,149	1,204
Industrial engineering	99	75	128	166	206	278		279	319	324	358	341	436	472	222	536	512
Mechanical engineering	20	22	73	127	166	199		254	247	295	326	354	360	371	400	417	420
Other engineering	104	180	259	323	490	299		615	69/	748	808	871	914	915	1,033	1,089	1,115
Engineering technology	06	116	125	152	103	114		215	205	242	243	306	300	307	383	383	441

SOURCES: National Center for Education Statistics, Earned Degrees and Completion Surveys (Washington, DC: 1995), unpublished tabulations; and National Science Foundation, Science Resources Studies Division, unpublished tabulations.

Appendix table 2-28. Earned master's degrees, by field, race/ethnicity, and citizenship: 1977-95

Field and race/ethnicity	1977	1979	1981	1985	1987	1989	1991	1993	1994	1995
				Total						
All degrees	318,241	302,075	296,798	287,213	290,532	311,050	338,498	370,973	389,008	399,428
Science and engineering	63,779	59,684	59,598 15,332	64,726	66,774	70,333	72,828	81,415	86,080	88,431
Math and computer sciences	6.496	6,101	6.787	9,989	11,808	12,829	12,956	14,251	14,529	14,522
Social sciences ^b	24,798	21,723	20,763	19,757	19,448	20,509	23,152	26,044	28,504	30,522
Engineering	16,251	15,510	16,716	20,935	22,057	23,735	24,007	27,658	28,707	28,617
Engineering technology	N A	NA	N A	816	883	1,135	1,188	1,555	1,547	1,577
			U.S. citizens	U.S. citizens and permanent residents	ent residents					
All degrees	300,334	281,811	273,184	254,401	246,939	263,166	285,260	310,449	324,203	331,744
Science and engineering	55,963	50,846	49,340	50,751	50,330	51,491	52,849	57,720	61,769	63,323
Natural sciences ^a	14,437	14,410	13,411	11,676	10,721	10,352	9,408	608'6	10,384	10,871
Math and computer sciences	5,760	5,099	5,342	7,385	8,179	8,370	8,527	8,789	8,868	8,823
Social sciences ^b	23,071	19,920	18,785	17,230	15,990	17,089	19,365	21,747	24,237	25,817
Engineering	12,695	11,417	11,802	14,460	15,440	15,680	15,549	17,375	18,280	17,812
Engineering technology	A A	Ą V	A A	296	712	606	626	1,175	1,256	1,268
White, all degrees	266,109	249,401	241,255	223,649	216,807	230,322	247,524	265,668	273,913	277,437
Science and engineering	50,420	45,748	43,967	43,982	43,360	43,945	44,513	47,975	50,711	51,417
Natural sciences ^a	13,405	13,282	12,411	10,559	9,623	9,262	8,300	8,504	8,859	9,242
Math and computer sciences	5,256	4,625	4,708	6,176	6,729	6,818	6,705	6,818	6,665	6,547
Social sciences ^b	20,315	17,759	16,701	15,061	14,171	15,033	16,873	18,733	20,718	21,807
Engineering	11,444 444	10,082 NA	10,147	12,186	12,837	12,832	12,635	13,920	14,469	13,821 982
	<u> </u>	<u> </u>	<u> </u>	020	5 6	000		- (- († (306
Asian, all degrees	5,145	5,519	6,304	7,805	8,129	10,174	11,070	13,169	14,559	15,906
Science and engineering	1,749	1,929	2,170	3,285	3,455	4,100	4,310	4,846	5,422	5,683
Natural sciences	388	469 0 10	365	450	464	545 045	532	619	698	802
Social sciences	967	233	350	677 808	370	1,072	1,203	1,303	1,401	0,4/0
Engineering	737	850	1.079	1.551	1.650	1.992	2.008	2.260	2.443	2.572
Engineering technology	Ą Z	Ϋ́	¥Z	, 25	, 46	40	09	40	, 46	, 55
Black, all degrees	21,041	19,422	17,152	13,960	13,173	13,455	15,857	18,897	20,936	22,954
Science and engineering	2,321	2,003	1,801	1,742	1,784	1,652	2,090	2,554	2,849	3,339
Natural sciences ^a	351	382	351	290	301	238	261	310	347	383
Math and computer sciences	200	136	137	233	280	257	383	406	474	498
Social sciences ^b	1,530	1,239	1,053	888	800	802	1,048	1,274	1,439	1,793
Engineering	240	246	260	330	403	355	398	564	589	999
Engineering technology	A A	A A	A A	37	42	22	47	61	72	82
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Appendix table 2-28. Earned master's degrees, by field, race/ethnicity, and citizenship: 1977-95

Field and race/ethnicity	1977	1979	1981	1985	1987	1989	1991	1993	1994	1995
Hispanic, all degrees	7,071	6,470	7,439	7,730	7,781	8,133	9,684	11,371	13,177	13,905
Science and engineering	1,325	1,001	1,237	1,514	1,584	1,585	1,736	2,092	2,514	2,585
Natural sciences ^a	245	227	251	332	310	266	281	334	436	392
Math and computer sciences	91	61	102	149	183	178	213	240	244	273
Social sciences ^b	738	498	299	289	579	673	774	937	1115	1209
Engineering	251	215	285	346	512	468	468	581	719	711
Engineering technology	Ϋ́	Ϋ́	N	9	17	10	19	25	37	40
Native American, all degrees	896	666	1,034	1,257	1,049	1,082	1,125	1,344	1,618	1,542
Science and engineering	148	165	165	228	147	209	200	253	273	299
Natural sciences ^a	48	20	33	45	23	41	34	46	44	52
Math and computer sciences	15	24	19	48	25	45	23	22	24	27
Social sciences ^b	62	29	82	88	61	06	103	135	145	177
Engineering	23	24	31	47	38	33	40	20	09	43
Engineering technology	Υ Y	A A	A A	2	26	2	ო	80	က	9
			F	Foreign citizens						
All degrees	17,345	19,427	22,058	26,952	28,264	32,123	37,611	44,109	46,506	48,756
Science and engineering	7,805	8,544	9,749	12,506	13,045	15,143	17,049	20,150	20,879	21,321
Natural sciences ^a	1,797	1,895	1,864	2,178	2,132	2,504	2,856	3,145	3,411	3,299
Math and computer sciences	736	937	1,368	2,394	2,903	3,418	3,878	4,917	2,007	5,036
Social sciences ^b	1,727	1,752	1,954	2,240	2,229	2,474	2,795	2,969	3,104	3,290
Engineering	3,545	3,960	4,563	5,694	5,781	6,747	7,520	9,119	9,357	969'6
Engineering technology	Υ Υ	Y Y	Ϋ́	124	127	131	172	279	291	309

N/A = not available

NOTES: Data by racial/ethnic group were collected on a biennial schedule until 1990 and annually thereafter. Data by racial/ethnic group are collected by broad fields of study only; therefore, these data cannot be adjusted to the exact field taxonomies used by the National Science Foundation.

«Natural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

^bSocial sciences include psychology, sociology, and other social sciences.

SOURCE: National Science Foundation, Science Resources Studies Division, Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1977-94, NSF 96-329 (Arlington, VA: 1996).

See text table 2-8.

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Appendix table 2-29. Graduate enrollment in engineering, by citizenship: 1985-96

Citizenship	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total enrollment	95,505	107,196	110,778	112,007	114,048	117,834	123,497	128,854	128,081	122,242	118,506	113,063
permanent residents Foreign students	69,930 25,575	77,895 29,301	78,609 32,169	76,579 35,428	77,133 36,915	78,687 39,147	81,948 41,549	84,831 44,023	,	82,325 39,917	80,153 38,353	74,403 38,660

NOTES: Data include full-time and part-time students. The schools surveyed by the Engineering Workforce Commission for engineering enrollments are slightly different from those surveyed by the National Science Foundation for graduate enrollments in all fields of science and engineering; therefore, numbers of students reported are slightly different.

SOURCE: American Association of Engineering Societies, Engineering Workforce Commission, *Engineering and Technology Enrollments, Fall 1979-1996* (Washington, DC: 1997), unpublished tabulations.

See figure 2-15.

Appendix table 2-30. Earned doctoral degrees, by field and sex: 1975-95

Field	1975	1977	1979	1981	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						Total do	Total doctoral degree recipients	gree recip	pients								
All degrees	32,952	31,716	31,239	31,356	31,281	31,337	31,297	31,902	32,370	33,501		36,067	37,522	38,826	39,771	41,017	41,610
Science and engineering	18,799	18,008	17,872	18,257	18,635	18,748	18,935	19,437	19,894	20,933	21,731	22,867	24,019	24,673	25,441	26,202	26,515
Natural sciences	8,103	7,676	7,817	7,995	8,194	8,336	8,436	8,483	8,655	9,172		9,763	10,159	10,435	10,529	11,079	11,024
Physical	3,076	2,721	2,674	2,627	2,814	2,851	2,934	3,120	3,238	3,350		3,524	3,625	3,780	3,699	3,977	3,840
Earth/atm/ocean	625	689	642	583	624	809	299	229	602	969		738	815	794	771	824	778
Biological & agricultural	4,402	4,266	4,501	4,785	4,756	4,877	4,903	4,804	4,815	5,127		5,501	5,719	5,861	6,059	6,278	6,406
Math/computer sciences	1,147	964	626	096	286	993	866	1,128	1,190	1,264		1,597	1,839	1,927	2,026	2,021	2,188
Mathematics	1,147	933	692	728	701	869	989	729	740	749		892	1,039	1,058	1,146	1,118	1,190
Computer sciences	0	31	210	232	286	295	310	339	450	515		202	800	869	880	903	866
Social & behavioral sciences	6,538	6,720	6,582	6,774	6,673	905'9	6,335	6,450	6,337	6,310		6,613	908'9	6,873	7,188	7,280	7,296
Psychology	2,751	2,990	3,091	3,358	3,347	3,257	3,118	3,126	3,173	3,074		3,281	3,250	3,263	3,419	3,380	3,419
Social sciences	3,787	3,730	3,491	3,416	3,326	3,249	3,217	3,324	3,164	3,236		3,332	3,556	3,610	3,769	3,900	3,877
Engineering	3,011	2,648	2,494	2,528	2,781	2,913	3,166	3,376	3,712	4,187		4,894	5,215	5,438	5,698	5,822	6,007
Chemical engineering	396	329	315	317	392	409	504	531	584	685		658	691	725	737	725	708
Civil engineering	361	336	302	358	397	408	391	429	477	531		553	275	594	624	684	929
Electrical engineering	714	299	611	549	625	099	716	908	779	1,010		1,276	1,405	1,483	1,543	1,673	1,731
Mechanical engineering	487	372	366	360	379	427	513	536	657	715		884	875	286	1,030	1,015	1,024
Materials engineering	272	248	236	234	268	271	303	305	392	374		440	489	485	535	539	288
Other engineering	781	969	664	710	720	738	739	692	823	872		1,083	1,180	1,164	1,229	1,186	1,300
							Males	Si									
All degrees	25,751	23,858	22,302	21,464	20,748	20,638	20,553	20,595	20,938	21,682	21,813	22,962	23,652	24,436	24,658	25,211	25,277
Science and engineering	15,870	14,775	14,128	14,056	13,920	13,956	14,044	14,270	14,582	15,271	15,622	16,498	17,088	17,593	17,789	18,283	18,242
Natural sciences	6,960	6,530	6,436	6,409	6,360	6,483	6,452	6,426	6,484	6,779	6,649	7,101	7,320	7,413	7,311	7,713	7,534
Physical	2,812	2,477	2,382	2,318	2,441	2,452	2,467	2,610	2,710	2,783	2,642	2,863	2,946	3,010	2,919	3,149	2,962
Earth/atm/ocean	262	630	584	527	529	505	491	464	490	260	275	265	929	909	611	641	809
Biological & agricultural	3,553	3,423	3,470	3,564	3,390	3,529	3,494	3,352	3,284	3,436	3,432	3,641	3,738	3,797	3,781	3,923	3,964
Math/computer sciences	1,038	837	833	822	838	841	829	626	1,000	1,087	1,208	1,329	1,523	1,602	1,624	1,648	1,737
Mathematics	1,038	811	650	616	288	583	285	809	615	628	704	734	840	853	882	882	925
Computer sciences	0	26	183	506	250	258	277	351	382	459	204	292	683	749	742	992	812
Social & behavioral sciences	4,913	4,834	4,427	4,396	4,065	3,870	3,765	3,734	3,628	3,504	3,597	3,589	3,497	3,646	3,678	3,735	3,658
Psychology	1,878	1,902	1,831	1,885	1,750	1,626	1,577	1,527	1,475	1,393	1,408	1,368	1,254	1,335	1,331	1,278	1,247
Social sciences	3,035	2,932	2,596	2,511	2,315	2,244	2,188	2,207	2,153	2,111	2,189	2,221	2,243	2,311	2,347	2,457	2,411
Engineering	2,959	2,574	2,432	2,429	2,657	2,762	2,968	3,151	3,470	3,901	4,168	4,479	4,748	4,932	5,176	5,187	5,313
Chemical engineering	391	319	306	306	369	382	463	470	524	620	632	280	809	612	643	612	299
Civil engineering	326	328	298	348	384	383	371	408	459	201	484	204	534	544	220	604	280
Electrical engineering	869	646	009	527	612	645	681	292	747	362	1,070	1,192	1,326	1,368	1,418	1,526	1,558
Mechanical engineering	483	366	361	354	371	412	487	518	640	989	731	846	818	942	973	946	961
Materials engineering	267	238	228	217	238	245	271	281	347	341	335	391	412	424	457	456	494
Other engineering	764	229	639	229	683	695	695	902	753	791	916	996	1,050	1,042	1,115	1,043	1,121
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Appendix table 2-30. Earned doctoral degrees, by field and sex: 1975-95

Field	1975	1977	1979	1981	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
							Females	les									
All degrees	7,201	7,858	8,937	9,892	10,533	10,699	10,744	11,307	11,432	11,819	12,513	13,105	13,870	14,420	15,113	15,806	16,333
Science and engineering	2,929	3,233	3,744	4,201	4,715	4,792	4,891	5,167	5,312	5,662	6,109	6,369	6,931	7,080	7,652	7,919	8,273
Natural sciences	1,143	1,146	1,381	1,586	1,834	1,853	1,984	2,057	2,171	2,393	2,536	2,662	2,839	3,022	3,218	3,366	3,490
Physical	264	244	292	309	373	333	467	510	528	292	619	661	629	770	780	828	878
Earth/atm/ocean	30	29	28	26	92	106	108	92	112	135	148	141	179	188	160	183	170
Biological & agricultural	849	843	1,031	1,221	1,366	1,348	1,409	1,452	1,531	1,691	1,769	1,860	1,981	2,064	2,278	2,355	2,442
Math/computer sciences	109	127	146	138	149	152	139	169	190	177	263	268	316	325	402	373	451
Mathematics	109	122	119	112	113	115	106	121	125	121	155	158	199	202	264	236	265
Computer sciences	0	2	27	56	36	37	33	48	99	26	108	110	117	120	138	137	186
Social & behavioral sciences	1,625	1,886	2,155	2,378	2,608	2,636	2,570	2,716	2,709	2,806	2,935	3,024	3,309	3,227	3,510	3,545	3,638
Psychology	873	1,088	1,260	1,473	1,597	1,631	1,541	1,599	1,698	1,681	1,800	1,913	1,996	1,928	2,088	2,102	2,172
Social sciences	752	798	895	902	1,011	1,005	1,029	1,117	1,011	1,125	1,135	1,111	1,313	1,299	1,422	1,443	1,466
Engineering	25	74	62	66	124	151	198	225	242	286	375	415	467	206	522	635	694
Chemical engineering	2	10	6	=	23	27	41	61	09	92	8	78	83	113	98	113	109
Civil engineering	2	∞	4	10	13	25	20	21	18	30	24	49	41	20	24	8	9/
Electrical engineering	16	21	=	22	13	15	32	38	32	48	29	8	79	115	125	147	173
Mechanical engineering	4	9	2	9	80	15	56	92	17	59	59	38	22	45	22	69	63
Materials engineering	2	10	80	17	30	56	35	24	45	33	42	49	77	61	78	83	94
Other engineering	17	19	25	33	37	43	44	63	20	81	100	117	130	122	114	143	179

SOURCE: National Science Foundation, Science Resources Studies Division, Selected Data on Science and Engineering Doctorate Awards: 1995, NSF 96-303 (Arlington, VA: 1996).

Science & Engineering Indicators – 1998

See figure 2-16.

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Appendix table 2-31. Earned doctoral degrees by field, race/ethnicity, and citizenship: 1977-95

Field and race/ethnicity	1977	1979	1981	1983	1985	1987	1989	1991	1992	1993	1994	1995
					Total							
All degrees	31,716	31,239	31,356	31,281	31,297	32,370	34,326	37,522	38,856	39,771	41,017	41,610
Science and engineering	18,008	17,872	18,257	18,635	18,935	19,894	21,731	24,019	24,673	25,441	26,202	26,515
Natural sciences ^b	7,676	7,817	7,995	8,194	8,436	8,655	9,185	10,159	10,435	10,529	11,079	11,024
Math and computer sciences	964	626	096	286	866	1,190	1,471	1,839	1,927	2,026	2,021	2,188
Social sciences ^c	6,720	6,582	6,774	6,673	6,335	6,337	6,532	908'9	6,873	7,188	7,280	7,296
Engineering	2,648	2,494	2,528	2,781	3,166	3,712	4,543	5,215	5,438	2,698	5,822	6,007
			n	.S. citizens	and perman	nent residents	•					
All degrees	27,487	26,784	26,341	25,634	24,694	24,562	25,026	27,418	27,956	28,675	30,877	31,910
Science and engineering	14,881	14,711	14,654	14,518	14,065	14,055	14,591	15,909	15,940	16,570	18,184	18,961
Natural sciences ^b	6,427	6,604	6,640	6,706	6,634	6,450	6,628	7,058	7,037	7,091	8,103	8,352
Math and computer sciences	692	778	713	664	631	671	824	696	966	1,099	1,200	1,388
Social sciences ^c	5,886	5,712	5,830	5,666	5,206	5,021	4,910	5,408	5,387	5,683	5,828	5,885
Engineering	1,799	1,617	1,471	1,482	1,594	1,913	2,229	2,474	2,520	2,697	3,053	3,336
White, all degrees	23,654	22,396	22,470	22,251	21,306	21,122	21,570	23,179	23,599	24,027	24,585	24,608
Science and engineering	12,875	12,314	12,573	12,671	12,169	12,052	12,501	13,323	13,326	13,735	13,890	13,879
Natural sciences ^b	5,598	5,620	5,771	5,981	5,903	5,663	5,800	6,111	6,019	5,950	3,016	5,974
Math and computer sciences	671	658	610	269	527	548	688	774	803	886	880	988
Social sciences ^c	5,177	4,879	5,099	4,993	4,551	4,383	4,287	4,601	4,624	4,874	4,866	4,831
Engineering	1,429	1,157	1,093	1,128	1,188	1,458	1,726	1,837	1,880	2,025	2,020	2,086
Asian, all degrees	910	1,102	1,073	1,042	1,070	1,168	1,268	1,531	1,761	2,012	3,545	4,300
Science and engineering	745	884	827	780	808	925	986	1,180	1,344	1,610	2,989	3,666
Natural sciences ^b	342	377	344	329	346	369	403	474	559	989	1,481	1,857
Math and computer sciences	42	22	99	54	20	29	92	123	138	156	259	346
Social sciences ^c	112	146	142	120	132	162	146	178	196	241	382	432
Engineering	249	306	285	247	281	327	361	405	451	527	867	1,031
Black, all degrees	1,191	1,112	1,110	1,005	1,043	910	962	1,160	1,113	1,277	1,274	1,455
Science and engineering	342	347	346	338	374	319	366	459	407	468	496	222
Natural sciences ^b	82	84	88	84	100	92	105	111	106	135	149	168
Math and computer sciences	6	12	Ξ	9	10	13	တ	19	6	4	21	16
Social sciences ^c	233	231	227	219	230	186	219	274	243	269	272	302
Engineering	15	20	19	59	34	25	33	22	49	20	54	71
Hispanic, all degrees	489	547	529	809	634	208	694	867	606	973	1,029	1,055
Science and engineering	203	234	240	284	296	357	382	492	513	542	548	268
Natural sciences ^b	92	84	93	98	107	138	157	191	208	226	254	232
Math and computer sciences	12	12	2	7	18	15	15	21	20	23	20	21
Social sciences ^c	91	114	126	162	149	170	163	220	214	227	208	238
Engineering	24	24	16	29	22	34	47	09	71	99	99	77
0 90 1												

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Appendix table 2-31. Earned doctoral degrees by field, race/ethnicity, and citizenship: 1977-95

Field and race/ethnicity	1977	1979	1981	1983	1985	1987	1989	1991	1992	1993	1994	1995
Native American, all degrees	99	81	85	82	96	115	94	132	149	120	142	148
Science and engineering	31	29	28	30	41	53	53	26	69	43	64	69
Natural sciences ^b	4	9	∞	13	21	20	25	27	26	17	24	56
Math and computer sciences	-	-	-	-	0	ო	2	-	4	2	ო	2
Social sciences ^c	15	19	15	15	19	23	19	22	28	22	31	31
Engineering	-	က	4	-	-	7	7	9	Ξ	7	9	10
				Temp	Temporary residents	ents						
Total, all degrees	3,448	3,587	3,940	4,498	5,227	5,612	6,648	9,312	9,953	9,934	9,406	8,806
Science and engineering	2,675	2,689	2,983	3,412	4,047	4,468	5,391	7,642	8,092	8,113	7,521	6,992
Natural sciences ^c	1,079	1,046	1,140	1,273	1,517	1,704	1,975	2,936	3,213	3,191	2,815	2,502
Math and computer sciences	170	181	226	281	327	445	524	846	876	865	791	747
Social sciences ^c	651	645	675	688	784	787	952	1,226	1,260	1,273	1,262	1,220
Engineering	775	817	942	1,170	1,419	1,532	1,940	2,634	2,743	2,784	2,653	2,523
				Citize	Citizenship unknown	own						
Total, all degrees	781	898	1,075	1,149	1,376	2,196	2,652	792	947	1,162	734	894
Science and engineering	452	472	620	202	823	1,371	1,749	468	641	758	497	562
Natural sciences ^b	170	167	215	215	285	501	582	165	185	247	161	170
Math and computer sciences	25	20	21	42	40	74	123	24	22	62	30	53
Social sciences ^c	183	225	269	319	345	529	670	172	226	232	190	191
Engineering	74	09	115	129	153	267	374	107	175	217	116	148

[&]quot;Data include all doctorates awarded to U.S. citizens and permanent residents, temporary residents, and persons whose citizenship is unknown.

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^bNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

natural sciences nere include physical, earn, annosphenc, occanographic, biological, and agricultural sciences Social sciences include psychology, sociology, and other social sciences.

SOURCE: National Science Foundation, Science Resources Studies Division, Selected Data on Science and Engineering Doctorate Awards: 1995, NSF 96-303 (Arlington, VA: 1996).

Appendix table 2-32. Earned doctoral degrees in science and engineering, by region/country: Most recent year

				Degre	e field		
Region/country	All doctoral degrees	All S&E doctoral degrees	Natural sciences ^a	Math & computer sciences	Agriculture	Social sciences ^b	Engineering
Total, three world regions	155,733	89,818	37,229	6,830	5,829	15,663	24,267
		Asia					
Total	32,087	15,678	6,304	224	2,048	775	6,327
China	4,364	3,230	1,191	NA	182	198	1,659
India	9,369	4,425	3,505	NA	572	NA	348
Japan	13,044	5,453	1,135	NA	1,008	301	3,009
South Korea	4,462	1,920	358	169	223	232	938
Taiwan	848	650	115	55	63	44	373
		Europe					
Total	78,791	45,647	20,120	4,386	2,576	7,030	11,535
European Union	60,364	33,488	16,769	2,856	1,764	4,736	7,363
Austria	1,634	851	268	98	123	105	257
Denmark	333	257	137	0	34	33	53
Finland	1,882	757	245	86	54	147	225
France	9,801	8,575	3,738	1,129	84	2,197	1,427
Germany	22,404	10,128	6,077	616	573	699	2,163
Greece	932	367	128	44	36	66	93
Ireland	344	252	156	21	13	11	51
Italy	3,603	1,432	640	NA	175	226	391
The Netherlands	2,405	1,308	516	NA	155	264	373
Spain	5,193	1,794	1,109	88	104	194	299
Sweden	2,072	1,255	399	172	62	148	474
United Kingdom	9,761	6,512	3,356	602	351	646	1,557
European Free Trade Associaton	4,304	2,009	814	135	172	347	541
Norway	500	169	7	5	42	8	107
Switzerland	3,804	1,840	807	130	130	339	434
Central Europe	14,123	10,150	2,537	1,395	640	1,947	3,631
Czech Republic	118	108	35	7	1	21	44
Russia	14,005	10,042	2,502	1,388	639	1,926	3,587
	N	orth Americ	ca				
Total	44,855	28,493	10,805	2,220	1,205	7,858	6,405
Canada	3,356	2,027	689	183	117	490	548
Mexico	488	259	120	15	10	79	35
United States	41,011	26,207	9.996	2,022	1,078	7,289	5,822

N/A = not available

NOTES: Data are compiled from numerous national and international sources, and degree fields may not be strictly comparable. U.K. data are for 1996. Data for China, Japan, South Korea, Taiwan, Austria, Switzerland, and the United States are for 1995. Data for Finland, France, Germany, Italy, Sweden, Norway, Czech Republic, Russia, Canada, and Mexico are for 1994. Data for Denmark, Greece, Ireland, the Netherlands, and Spain are for 1993. Indian data are for 1991. Japanese data include "thesis" doctorates called Ronbun Hakase, earned by employees in industry.

SOURCES: ASIA: China - National Research Center for Science and Technology for Development, unpublished tabulations, and UNESCO, Statistical Yearbook (Paris: 1996); India - Department of Science and Technology, Research and Development Statistics 1994-95 (New Delhi: 1996); Japan - Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); South Korea - Ministry of Education, Statistical Yearbook of Education (Seoul: 1996); Taiwan—Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996); EUROPEAN UNION: Austria—Austrian Central Statistical Office, unpublished tabulations; Denmark—Department of Higher Education, Ministry of Education, unpublished tabulations (1997); Finland—Central Statistical Office, unpublished tabulations (1997), and OECD/CERI; France-Ministère de l'Éducation Nationale, Repères et Références Statistiques sur les Enseignements et la Formation (Vanves, France: 1996); Germany-Statistisches Bundesamt, Prüfungen an Hochschulen (Wiesbaden); Greece-National Statistical Service of Greece, unpublished tabulations (1997), and OECD/CERI; Ireland - OECD/CERI; Italy - Consiglio nazionale delle ricerche, unpublished tabulations (1997); the Netherlands - Department for Statistics of Education and Science, Netherlands Central Bureau of Statistics, unpublished tabulations (1997); Spain - Estadisticas e Investigaciones Sociales, Instituto National de Estadistica, unpublished tabulations (1997) and OECD/CERI; Sweden - Statistics Sweden, unpublished tabulations (1997), and OECD/CERI; United Kingdom - Higher Education Statistical Agency, Students in Higher Education Institutions, 1995/96 (Cheltenham: 1997); EUROPEAN FREE TRADE ASSOCIATION: Norway-Institute for Studies in Research and Higher Education, the Norwegian Research Council, unpublished tabulations (1997); Switzerland - Swiss Federal Statistical Office, unpublished tabulations (1997); CENTRAL AND EASTERN EUROPE: Czech Republic – UNESCO (1996); Russia – UNESCO (1996); NORTH AMERICA: Canada – UNESCO (1996) and OECD/CERI; Mexico – Asociación Nacional de Universidades e Instituciones de Educación Superior, Anuario Estadístico 1995: Posgrado (Mexico: 1996); and United States - National Science Foundation, Science Resources Studies Division, Science and Engineering Degrees 1966-94, NSF 96-321 (Arlington, VA: 1996).

^aNatural sciences here include physical, earth, atmospheric, oceanographic, and biological sciences.

^bSocial sciences include psychology, sociology, and other social sciences.

Appendix table 2-33.

Proportion of NS&E doctoral degrees earned by foreign students in selected countries: 1995 or most current year (Percentages)

	Foreign doc	toral recipients
Country	Natural sciences	Engineering
United States	40.5	57.9
United Kingdom	28.5	49.1
France	29.1	34.2
Germany	7.9	15.8
Japan	22.1	32.2

NOTE: Data for Germany and Japan are for 1994.

NS&E = natural sciences and engineering

SOURCES: France—Ministère de l'Éducation Nationale, Repères et Références Statistiques sur les Enseignements et la Formation (Vanves, France: 1996); Germany—Statistiches Bundesamt, Prüfungen an Hochschulen (Wiesbaden); Japan—Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: Annual Series); United Kingdom—Higher Education Statistical Agency, unpublished tabulations; United States—National Science Foundation, Science Resources Studies Division, Selected Data on Science and Engineering Doctorate Awards, 1995, NSF 96-303 (Arlington, VA: 1996).

See figure 2-17. Science & Engineering Indicators – 1998

Appendix table 2-34. Foreign students enrolled in U.S. universities from 12 major places of origin, by educational level and major field of study: 1995-96

				Р	ercentage in	S&E fields		Percenta non-S&E	•
Country	Total all fields	Educational level	Number of students surveyed ^a	Natural sciences	Math & computer sciences	Social sciences	Engineering	Business management	Other
Japan	45,531	Undergraduate	32,034	4.5	3.7	15.9	3.1	19.6	53.2
		Graduate	7,819	7.3	3.4	24.7	7.4	17.2	40.0
China	39,613	Undergraduate	4,851	6.8	14.8	4.1	10.4	27.6	36.3
		Graduate	32,512	32.6	13.1	5.9	24.9	8.9	14.6
South Korea	36,231	Undergraduate	16,333	5.8	7.1	6.3	8.0	21.7	51.1
		Graduate	15,045	15.1	7.0	11.2	18.7	12.1	35.9
Taiwan	32,702	Undergraduate	11,522	3.7	8.2	4.2	9.6	33.3	41.0
		Graduate	18,904	12.0	10.1	6.7	24.2	19.4	27.6
India	31,743	Undergraduate	6,049	7.9	14.9	5.8	21.5	25.0	24.9
		Graduate	25,593	13.2	17.1	4.2	41.3	11.7	12.5
Canada	23,005	Undergraduate	12,987	7.8	2.2	14.5	6.1	13.3	56.1
		Graduate	8,851	9.9	1.5	15.5	4.6	6.7	61.8
Malaysia	14,015	Undergraduate	11,630	3.2	6.8	3.8	33.8	33.7	18.7
		Graduate	1,956	8.6	11.0	11.6	20.1	24.2	24.5
Indonesia	12,820	Undergraduate	9,325	2.7	5.5	2.9	21.6	48.8	18.5
		Graduate	2,947	10.2	6.5	10.6	22.0	35.7	15.0
Thailand	12,165	Undergraduate	3,599	3.6	8.0	4.6	15.0	32.7	36.1
		Graduate	7,347	7.6	5.2	5.6	19.5	47.7	14.4
Hong Kong	12,018	Undergraduate	9,055	3.6	8.6	6.0	14.5	40.8	26.5
- 0	•	Graduate	2,348	12.1	12.5	10.9	16.5	22.3	25.7
Germany	9,017	Undergraduate	3,662	7.6	4.2	10.8	5.1	24.1	48.2
•	•	Graduate	4,304	18.1	7.7	13.0	12.3	17.9	31.0
Mexico	8,687	Undergraduate	5,079	5.0	4.4	6.9	14.4	26.1	43.2
	,	Graduate	3,070	21.4	7.1	14.7	19.3	14.8	22.7

NOTE: Data Include foreign students in all levels of U.S. higher education.

^aThe numbers of foreign students surveyed by level and field of study do not equal the total numbers of foreign students in all fields from each country. Many universities were unable to respond to the detailed questions posed by the survey regarding the level and major field of study for their registered foreign students.

SOURCES: Institute of International Education (IIE), Open Doors, 1995-96: Report on International Education Exchange (New York: 1996); and IIE, Profiles 1995-96, Detailed Analyses of the Foreign Student Population (New York), unpublished tabulations.

Appendix table 2-35. Earned doctoral degrees, by field and citizenship: 1986-95

Field	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
				Total ^a						
All degrees	31,902	32,370	33,501	34,326	36,067	37,522	38,856	39,771	41,017	41,610
Science and engineering	19,437	19,894	20,933	21,731	22,867	24,019	24,673	25,441	26,202	26,515
Natural sciences ^b	8,483	8,655	9,172	9,185	9,763	10,159	10,435	10,529	11,079	11,024
Math and computer sciences	1,128	1,190	1,264	1,471	1,597	1,839	1,927	2,026	2,021	2,188
Social sciences ^c	6,450	6,337	6,310	6,532	6,613	908'9	6,873	7,188	7,280	7,296
Engineering	3,376	3,712	4,187	4,543	4,894	5,215	5,438	5,698	5,822	6,007
				U.S. citizens						
All degrees	23,086	22,984	23,291	23,400	24,905	25,561	25,977	26,420	27,129	27,603
Science and engineering	13,022	12,966	13,369	13,467	14,166	14,624	14,558	14,929	15,162	15,460
Natural sciences ^b	6,139	6,070	6,282	6,225	6,505	6,585	6,501	6,461	6,642	6,595
Math and computer sciences	268	588	626	731	723	851	876	921	930	1,038
Social sciences ^c	4,932	4,750	4,681	4,647	4,981	5,102	5,072	5,319	5,375	5,445
Engineering	1,383	1,558	1,780	1,864	1,957	2,086	2,109	2,228	2,215	2,382
			ž	Non-U.S. citizens						
All degrees	6,709	7,190	7,817	8,274	9,791	11,169	11,932	12,189	13,154	13,113
Science and engineering	5,154	5,557	990'9	6,515	7,768	8,927	9,474	9,754	10,543	10,493
Natural sciences ^b	1,896	2,084	2,333	2,378	2,974	3,409	3,749	3,821	4,276	4,259
Math and computer sciences	478	528	292	617	797	964	966	1,043	1,061	1,097
Social sciences ^c	1,065	1,058	1,079	1,215	1,331	1,532	1,575	1,637	1,715	1,660
Engineering	1,715	1,887	2,087	2,305	2,666	3,022	3,154	3,253	3,491	3,477
			Non-U.S. citiz	Non-U.S. citizens with permanent visas	anent visas					
All degrees	1,433	1,578	1,622	1,626	1,698	1,857	1,979	2,255	3,748	4,307
Science and engineering	994	1,089	1,130	1,124	1,197	1,285	1,382	1,641	3,022	3,501
Natural sciences ^b	321	380	429	403	437	473	536	630	1,461	1,757
Math and computer sciences	83	83	98	93	102	118	120	178	270	320
Social sciences ^c	247	271	249	263	269	306	315	364	453	440
Engineering	343	355	366	365	389	388	411	469	838	954
			Non-U.S. citi	Non-U.S. citizens with temporary visas	orary visas					
All degrees	5,276	5,612	6,195	6,648	8,093	9,312	9,953	9,934	9,406	8,806
Science and engineering	4,160	4,468	4,936	5,391	6,571	7,642	8,092	8,113	7,521	6,992
Natural sciences ^b	1,575	1,704	1,904	1,975	2,537	2,936	2,741	3,191	2,815	2,502
Math and computer sciences	395	445	481	524	695	846	876	865	791	747
Social sciences ^c	818	787	830	952	1,062	1,226	1,260	1,273	1,262	1,220
Engineering	1,372	1,532	1,721	1,940	2,277	2,634	2,743	2,784	2,653	2,523
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Appendix table 2-35. Earned doctoral degrees, by field and citizenship: 1986-95

Field	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
			Citizen	Citizenship unknown						
All degrees	2,107	2,196	2,393	2,652	1,371	792	947	1,162	734	894
Science and engineering	1,261	1,371	1,498	1,749	933	468	641	758	497	562
Natural sciences ^b	448	446	557	582	284	165	185	247	161	170
Math and computer sciences	82	74	71	123	77	24	55	62	30	53
Social sciences ^c	453	529	550	029	301	172	226	232	190	191
Engineering	278	267	320	374	271	107	175	217	116	148

Data include all doctorates awarded to U.S. citizens and permanent residents, temporary residents, and persons whose citizenship is unknown.

^aNatural sciences here include physical, earth, atmospheric, oceanographic, biological, and agricultural sciences.

Social sciences include psychology, sociology, and other social sciences.

SOURCE: National Science Foundation, Science Resources Studies Division, Selected Data on Science and Engineering Doctorate Awards: 1995, NSF 96-303 (Arlington, VA: 1996).

See figure 2-17.

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Appendix table 2-36.

Total S&E doctoral degrees earned by Asian students from Asian and U.S. universities: 1975-95

	Asian universities	U.S. universities
1975	4,057	NA
1976	4,634	NA
1977	4,959	NA
1978	5,211	NA
1979	5,597	NA
1980	5,892	991
1981	6,149	1,031
1982	6,408	1,168
1983	6,652	1,339
1984	7,091	1,531
1985	7,848	1,761
1986	8,032	1,889
1987	8,422	2,218
1988	9,701	2,511
1989	10,144	2,872
1990	10,283	4,008
1991	11,053	4,911
1992	11,767	5,406
1993	12,235	5,628
1994	13,812	6,229
1995	15,678	6,352

NA = not available

NOTE: Asian countries comprise China, India, Japan, South Korea, and Taiwan. Asian students in U.S. universities include those on either temporary or permanent visas.

SOURCES: China - National Center for Science and Technology for Development, unpublished tabulations, 1997; India - Department of Science and Technology, Research and Development Statistics 1994-95 (New Delhi: 1996); Japan-Ministry of Education, Science, and Culture (Monbusho), Monbusho Survey of Education (Tokyo: annual series); South Korea-Ministry of Education, Statistical Yearbook of Education, 1996 (Seoul: 1996); Taiwan-Ministry of Education, Educational Statistics of the Republic of China (Taipei: 1996); United States-National Science Foundation, Science Resources Studies Division (NSF/SRS), Selected Data on Science and Engineering Doctorate Awards: 1995, NSF 96-303 (Arlington, VA: 1996); and NSF/SRS, Science and Engineering Doctorates: 1960-84 (Washington, DC: n.d.).

See figure 2-18. Science & Engineering Indicators – 1998

Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

		-	1990				1991	_				1992					1993		
Begion /country	Total Ph.D.	Plan to stav in U.S.	to U.S.	Firm plans to	ans to U.S.	Total Ph.D.	Plan to stav in U.S.	Firm plans to	ins to	Total Ph.D.	Plan to stav in U.S.	to U.S.	Firm plans to	ns to	Total Ph.D.	Plar stav i	Plan to av in U.S.	Firm plans to	ans to
oforigin	recipients	No.	%	No.	%	recipients	No. %		%	recipients	Š.	%	No. %	%	recipients	Š.	No. %	No. %	%
								All fi	All fields										
Asia	5,224	2,390	45.8	1,727	33.1	6,252	3,596 57.5	2,268	36.3	6,938	4,375	63.1		36.4	7,136	4,397	61.6	2,367	33.2
China	1,225	725	59.2	505	41.0	1,919		920	47.9	2,238	1,980	88.5		48.3	2,416	2,134	88.3	1,077	44.6
Taiwan	1,149	477	41.5	314	27.3	1,321	635 48.1	367	27.8	1,431	702	49.1	364	25.4	1,456	584	40.1	304	20.9
Japan	186	73	39.2	22	29.6	164	66 40.2	45	27.4	172	74	43.0	46	26.7	182	99	36.3	43	23.6
South Korea	1,259	367	29.2	272	21.6	1,396	454 32.5	285	20.4	1,474	464	31.5	272	18.5	1,409	462	32.8	236	16.7
India	881	286	66.5	470	53.3	924	689 74.6	518	56.1	1,072	880	82.1	609	56.8	1,139	920	80.8	217	20.7
Other	524	162	30.9	114	21.8	528	229 43.4	133	25.2	551	275	49.9	154	27.9	534	231	43.3	130	24.3
Europe	1,097	540	49.2	411	37.5	1,329	740 55.7	534	40.2	1,332	808	2.09	544	40.8	1,461	842	9.79	552	37.8
Greece	137	29	48.9	20	36.5	185	96 51.9	99	35.7	168	94	26.0	28	34.5	199	116	58.3	78	39.2
United Kingdom	172	119	69.2	06	52.3	207	142 68.6	101	48.8	216	161	74.5	117	54.2	230	169	73.5	120	52.2
Germany	169	82	50.3	92	38.5	181	109 60.2	80	44.2	189	116	61.4	72	38.1	250	148	59.2	91	36.4
Italy	88	32	39.8	24	27.3	115		44	38.3	66	51	51.5	59	29.3	101	43	45.6	31	30.7
France	94	4	43.6	30	31.9	107	55 51.4	40	37.4	116	63	54.3	45	36.2	136	62	45.6	40	29.4
Spain	73	27	37.0	24	32.9	103		33	37.9	91	22	62.6	4	45.1	100	54	54.0	34	34.0
Other	364	166	45.6	128	35.2	431	230 53.4	164	38.1	453	267	58.9	185 ,	40.8	445	250	56.2	158	35.5
N./S. America	1,099	434	39.5	329	29.9	1,293	599 46.3	434	33.6	1,302	615	47.2	393	30.2	1,279	589	46.1	382	29.9
Canada	419	191	45.6	153	36.5	511	241 47.2	187	36.6	609	260	51.1	191	37.5	486	239	49.2	176	36.2
Mexico	130		36.2	32	24.6	156	71 45.5	51	32.7	149	49	32.9		18.1	162	99	40.7	35	21.6
Argentina	78	35	41.0	24	30.8	73	46 63.0	33	45.2	101	47	46.5		27.7	89	37	54.4	25	36.8
Brazil	129		17.1	48	14.0	149	49 32.9	33	22.1	163	46	28.2	. 55	13.5	181	44	24.3	26	14.4
Chile	26		41.1	15	26.8	70	25 35.7	20	28.6	99	35	53.8		38.5	64	30	46.9	17	26.6
Colombia	46		52.2	18	39.1	64		19	29.7	54	58	53.7	4	25.9	47	21	44.7	17	36.2
Peru	28	14	50.0	12	45.9	40		16	40.0	42	27	64.3	19	45.2	48	27	56.3	17	35.4
Other	213	81	38.0	22	26.8	230	107 46.5		32.6	219	122	55.7	29	30.6	223	125	56.1	69	30.9

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

Region/country of origin	Total	Plan to	= 4							
Region/country of origin			2	Firm plans to	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to
of origin	Ph.D.	stay in U.S.	U.S.	stay in U.S.	Ph.D.	stay in U.S.	stay in U.S.	Ph.D.	stay in U.S.	stay in U.S.
oi- W	recipients	No.	%	No. %	recipients	No. %	No. %	recipients	No.	No. %
Aci.							All fields			
Asid	7,903	5,100	64.5	2,654 33.6	8,014	5,407 67.5	2,827 35.3	8,179	5,593 68.4	3,491 42.7
China	2,772	2,548	91.9	1,223 44.1	2,979	2,744 92.1	1,341 45.0	3,201		1,788 55.9
Taiwan	1,576	654	41.5		1,485		293 19.7	1,404		
Japan	235	92	40.4	57 24.3	233	102 43.8	69 29.6	245	104 42.4	67 27.3
South Korea	1,475	522	35.4	267 18.1	1,306	466 35.7	244 18.7	1,260	441 35.0	
India	1,289	1,049	81.4	662 51.4	1,425	1,179 82.7	746 52.4	1,500	1,264 84.3	882 58.8
Other	556	232	41.7	123 22.1	286	247 42.2	134 22.9	269		
Europe	1,506	905	59.9	597 39.6	1,644	1,033 62.8	656 39.9	1,611	1,038 64.4	711 44.1
Greece	188	82	45.2	60 31.9	197		60 30.5	152	85 55.9	
United Kingdom	219	156	71.2	97 44.3	222	167 75.2	116 52.3	206	154 74.8	107 51.9
Germany	257	167	65.0	113 44.0	306			246		
Italy	108	22	52.8		116			102	48 47.1	31 30.4
France	132	77	58.3	45 34.1	117			102		38 37.3
Spain	113	29	52.2	43 38.1	102	64 62.7	50 49.0	120	84 70.0	
Other	489	301	9.1.6	209 42.7	584			683	459 67.2	318 46.6
N./S. America	1,368	641	46.9	405 29.6	1,326	620 46.8		1,426		450 31.6
Canada	490	239	48.8	174 35.5	524	278 53.1	171 32.6	505	269 53.3	190 37.6
Mexico	178	29	37.6	37 20.8	162			180		41 22.8
Argentina	89	45	66.2		77			91	60 62.9	39 42.9
Brazil	202	09	29.7		175			262	66 25.2	46 17.6
Chile	24	19	35.2	14 25.9	20		11 22.0	42	14 33.3	10 23.8
Colombia	29	35	59.3		99	24 42.9		54	27 50.0	
Peru	42	30	71.4	16 38.1	39	23 59.0	14 35.9	45	31 68.9	21 46.7
Other	275	146	53.1	84 30.5	243	132 54.3	81 33.3	247	133 53.8	85 34.4

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

		1990	90				1991					1992					1993		
Begion /country	Total	Plan to		Firm plans to	o s	Total Ph.D.	Plan to	_	Firm plans to	Total	Plan to	t s	Firm plans to	ns to	Total	Pla	Plan to	Firm plans to	ans to
oforigin	recipients	No.		No.		recipients	No. %		%	recipients	S S	%	No. %	%	recipients	9	No. %	No. %	%
								Science & engineering	k engine€	əring									
Asia	4,380	2,113 48	48.2 1	1,521 34	34.7	5,280	3,189 60.4	1,995	37.8	5,786	3,784	65.4	2,165	37.4	5,996	3,879	64.7	2,078	34.7
China	1,150	687 59	59.7	478 41	41.6	1,792		861	48.0	2,044	1,808	88.5		48.4	2,227	1,975	88.7	1,008	45.3
Taiwan	1,012	451 44	44.6	299 29	9.5	1,123	581 51.7	340	30.3	1,240	640	51.6	329	26.5	1,213	530	43.7	282	23.2
Japan	147	60 40	40.8	48 32	2.7	125	50 40.0	35	28.0	132	51	38.6	78	21.2	132	43	32.6	27	20.5
South Korea	971	307 31	31.6		23.3	1,107	390 35.2	243	22.0	1,123	373	33.2	520	19.6	1,118	394	35.2	201	18.0
India	709	467 65	62.9		2.3	752	554 73.7	408	54.3	860	703	81.7	485	56.4	932	759	81.4	462	49.6
Other	391	141 36	36.1	99 25	5.3	381	186 48.8	108	28.3	387	209	54.0	113	29.2	374	178	47.6	86	26.2
Europe	802	383 47	47.8	288 35	5.9	971	524 54.0	385	39.6	947	547	87.8	376	39.7	1,083	593	54.8	404	37.3
Greece	125	65 52	52.0	48 38	38.4	168	90 53.6		36.9	149	85	55.0	49	32.9	174	101	58.0	89	39.1
United Kingdom	104	73 70	70.2	53 51	0.1	134	91 67.9	99	49.3	139	101	72.7	75	54.0	157	113	72.0	86	54.8
Germany	123	59 48	48.0	46 37	7.4	118	67 56.8		43.2	124	29	54.0	44	35.5	164	86	52.4	22	33.5
Italy	63		36.5	15 25	3.8	98	37 43.0		34.9	73	37	20.7	25	34.2	92	30	39.5	23	30.3
France	92	25 38	38.5	16 24	4.6	29	28 41.8		31.3	77	31	40.3	50	26.0	93	29	31.2	17	18.3
Spain	40	11 27	.5	11 27	7.5	29	26 44.1		32.2	45	27	0.09	700	44.4	63	27	42.9	21	33.3
Other	282	127 45	45.0	99 35	5.1	339	185 54.6	136	40.1	340	202	59.4	143 ,	42.1	326	207	58.1	134	37.6
N./S. America	786	312 39	39.7	236 30	0.0	606	438 48.2	328	36.1	606	435	47.9	277	30.5	006	415	46.1	282	31.3
Canada	252	121 48	48.0	66 36	39.3	296	162 54.7	127	45.9	304	171	56.3	132	43.4	285	164	57.5	131	46.0
Mexico	104	34 32	32.7		5.2	128			35.2	115	36	33.9		19.1	139	54	38.8	30	21.6
Argentina	92	28 43	43.1	22 33	3.8	62	39 62.9	29	46.8	98	33	45.3	55	25.6	53	26	49.1	17	32.1
Brazil	86	17 17	17.3	13 13	3.3	118	35 29.7		21.2	133	37	27.8	4	13.5	151	34	22.5	19	12.6
Chile	20	18 36	36.0		4.0	24	21 38.9		31.5	48	25	52.1	18	37.5	52	24	46.2	15	28.8
Colombia	40	21 52	52.5	16 40	0.0	49			26.5	37	20	54.1	6	24.3	35	=	31.4	10	28.6
Peru	22	10 45	45.5	8 36	5.4	32	23 65.7	15	45.9	31	22	71.0	15	48.4	34	21	61.8	12	35.3
Other	155	63 40	40.6	45 29	0.6	167	76 45.5	22	34.1	155	85	52.9	4	26.5	151	81	53.6	48	31.8
																			1

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

Total	·	Firm plans to stay in U.S.	Total	Plan to	Firm plans to	1		i
country	_	stay in U.S. No. %				Total	Plan to	Firm plans to
Corea		No. %	Ph.D.	stay in U.S.	stay in U.S.	Ph.D.	stay in U.S.	stay in U.S.
7			recipients	No. %	No. %	recipients	No. %	No. %
7 7 7 7 9				Scie	Science & engineering	ring		
		2,352 35.7	6,763	4,812 71.2	2,514 37.2	6,941	5,002 72.1	3,153 45.4
			2,752	2,545 92.5		2,952	2,689 91.1	1,684 57.0
			1,240	615 49.6	275 22.2	1,153	596 51.7	320 27.8
		51 28.0	155	63 40.6	48 31.0	165	71 43.0	44 26.7
- -		230 20.1	1,000	388 38.8	210 21.0	226	368 37.7	237 24.3
-		536 50.3	1,206	1,003 83.2	632 52.4	1,276	1,084 85.0	753 59.0
· ·	178 47.1	98 25.9	410	198 48.3	104 25.4	418	194 46.4	115 27.5
	638 58.1	446 40.6	1,199	740 61.7	487 40.6	1,173	735 62.7	513 43.7
		54 32.5	174	98 56.3		133	76 57.1	51 38.3
	90 68.7	59 45.0	134	102 76.1	77 57.5	119	86 72.3	61 51.3
	124 63.3	93 47.4	208	124 59.6	83 39.9	171	103 60.2	75 43.9
			81	37 45.7		77	34 44.2	22 28.6
France 96	51 53.1	30 31.3	83	38 45.8		69	31 44.9	22 31.9
Spain 58		20 34.5	51	29 56.9	24 47.1	99	41 62.1	28 42.4
Other 368	233 63.3	169 45.9	468	312 66.7	201 42.9	538	364 67.7	254 47.2
N./S. America 955	462 48.4	302 31.6	862	417 48.4	276 32.0	686	484 48.9	322 32.6
Canada 275	160 58.2	123 44.7	273			277		
	49 34.5		128	45 35.2	26 20.3	158	59 37.3	32 20.3
Argentina 56	37 66.1	28 50.0	49	22 44.9	17 34.7	29	43 64.2	27 40.3
Brazil 157	45 28.7	26 16.6	137	39 28.5	28 20.4	207	53 25.6	37 17.9
Chile 42	14 33.3		38	14 36.8	7 18.4	36	12 33.3	8 22.2
Colombia 48	28 58.3	9 18.8	45	15 33.3	10 22.2	42	20 47.6	13 31.0
Peru 32	20 62.5	12 37.5	26	16 61.5	10 38.5	30	21 70.0	14 46.7
Other 203	109 53.7	64 31.5	166	93 56.0	59 35.5	172	94 54.7	61 35.5

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

Region /country Ph.D. stay in U.S. of origin recipients No. % Asia 2,200 1,172 53.3 China 763 474 62.1 Taiwan 763 474 62.1 Japan 58 221 48.3 Japan 319 220 69.0 Other 195 58 29.7 Europe 422 203 48.1 Greece 50 27 54.0 United Kingdom 54 40 74.1 Germany 76 35 46.1 Italy 34 11 32.4 France 27 9 33.3 Spain 163 77 47.2 MAS. America 419 157 37.5	ᇣᄀᆡᆝ	Total Ph.D. recipients 2,610 1,229 421	Plan to stay in U.S. No. %	Firm plans to	Total	-		F	ċ		i	
2,200 1,172 763 474 458 221 58 31 407 168 319 220 195 58 422 203 50 27 54 40 76 35 34 11 27 9 163 77	No. % 890 40.5 357 46.8 153 33.4 25 43.1 134 32.9 180 56.4 41 21.0	2,610 1,229 421 46	No.	stay in U.S.	Ph.D.	Plan to stay in U.S.	Firm plans to stay in U.S.	lotal Ph.D.	Plan to stay in U.S.	Plan to ay in U.S.	Firm plans to stay in U.S.	ο.
2,200 1,172 763 474 458 221 58 31 407 168 319 220 195 58 422 203 50 27 54 40 76 35 34 11 27 9 163 77		2,610 1,229 421 46		No. %	recipients	No. %	No. %	recipients	No.	%	No. %	
2,200 1,172 763 474 458 221 58 31 407 168 319 220 195 58 422 203 50 27 50 27 54 40 76 35 11 8 4		2,610 1,229 421 46		Natural sciences	St							
763 474 458 221 58 31 407 168 319 220 195 58 422 203 50 27 54 40 76 35 34 11 27 9 18 4		1,229 421 46		1,186 45.4	2,958		1,362 46.0		2,225	73.6	1,303	43.1
458 221 58 31 407 168 319 220 195 58 422 203 50 27 54 40 76 35 34 11 27 9 18 4		421 46	997 81.1		1,423	1,271 89.3		5 1,508	1,348	89.4	751	49.8
58 31 407 168 319 220 195 58 422 203 50 27 54 40 76 35 34 11 27 9 18 4 163 77		46	247 58.7	152 36.1	504		175 34.7		270	52.5	164	31.9
407 168 319 220 195 58 422 203 50 27 54 40 76 35 34 11 27 9 18 4				17 37.0	20		17 34.0		17	35.4	15	31.3
319 220 195 58 422 203 50 27 54 40 76 35 34 11 27 9 18 4 163 77		422	187 44.3	132 31.3	418		127 30.4		195	48.5	125	31.1
195 58 422 203 50 27 54 40 76 35 34 11 27 9 18 4 163 77		304	225 74.0	174 57.2	365	307 84.1	220 60.3	3 382	315	82.5	200	52.4
422 203 50 27 54 40 76 35 34 11 27 9 18 4 163 77		188	95 50.5	59 31.4	198		60 30.3		80	46.8	48	28.1
50 27 54 40 76 35 34 11 27 9 18 4 163 77		542	301 55.5	227 41.9	202		206 40.6		332	55.4	232	38.7
54 40 76 35 34 11 27 9 18 4 163 77		69		32 46.4	99	36 54.5			46	26.7	30	39.0
76 35 34 11 27 9 18 4 163 77 419 157	31 57.4	75	54 72.0	45 60.0	20	48 68.6	37 52.9	96 6	69	72.6	22	57.9
34 11 27 9 18 4 163 77 419 157		82	45 54.9	37 45.1	78	42 53.8	30 38.5		49	49.0	32	32.0
27 9 18 4 163 77 419 157	9 26.5	45	23 51.1	17 37.8	43	19 44.2	13 30.2		16	36.4	13	29.5
18 4 163 77 419 157	5 18.5	37	16 43.2	9 24.3	40	16 40.0	11 27.5		15	30.6	Ξ	22.4
. 163 77 419 157	4 22.2	37		9 24.3	16		8 50.C		20	2.99	15	50.0
419 157	63 38.7	197	106 53.8	78 39.6	194	118 60.8	83 42.8		117	57.4	9/	37.3
	118 28.2	514	245 47.7	189 36.8	503	232 46.1	153 30.4	4 470	225	47.9	165	35.1
Canada 130 61 46.9	49 37.7	154	93 60.4	76 49.4	163	91 55.8	72 44.2		87	62.1	73	52.1
65 19	12 18.5	80		26 32.5	69		16 23.2		31	36.9	19	22.6
Argentina 42 17 40.5	13 31.0	34	21 61.8	18 52.9	45	18 40.0	12 26.7		16	51.6	13	41.9
Brazil 44 10 22.7	8 18.2	99	14 21.2	11 16.7	62		9 11.4		16	21.3	10	13.3
22 9	6 27.3	33		12 36.4	24	18 75.0	13 54.2		17	20.0	12	35.3
27 12	10 37.0	26	10 38.5	6 23.1	22	10 45.5	3 13.6		9	28.6	2	23.8
Peru 11 4 36.4	4 36.4	18	9 50.0	6 33.3	12	8 66.7	0.05		80	2.99	7	58.3
Other 78 25 32.1	16 20.5	103	47 45.6	34 33.0	88	43 48.3	22 24.7		44	60.3	56	35.6

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

Region/country of origin		i								
	Total	Plan to	0	Firm plans to	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to
	Ph.D.	stay in U.S.	J.S.	stay in U.S.	Ph.D.	stay in U.S.	stay in U.S.	Ph.D.	stay in U.S.	stay in U.S.
Asia	recipients	No.	%	No. %	recipients	No. %	No. %	recipients	No. %	No. %
Asia						۷	Natural sciences	s		
	3,359	2,571	76.5	1,473 43.9	3,447	2,715 78.8	1,525 44.2	3,604	2,843 78.9	1,852 51.4
China	1,665	1,554	93.3	834 50.1	1,802	1,671 92.7	883 49.0	1,960	1,810 92.3	
Taiwan	209		52.3	154 30.3	502	290 57.8	140 27.9	462	259 56.1	155 33.5
Japan	29		9.75	23 39.0	51	25 49.0	19 37.3	54	28 51.9	21 38.9
South Korea	473	242	51.2	152 32.1	414	220 53.1	147 35.5	430	208 48.4	
India	474		82.1	251 53.0	499	417 83.6	281 56.3	520	454 87.3	316 60.8
Other	179	7 98	48.0	59 33.0	179	92 51.4	55 30.7	178	84 47.2	52 29.2
Europe	631	371	58.8	275 43.6	675	405 60.0	282 41.8	269	460 66.0	327 46.9
Greece	84		42.9		87	43 49.4	30 34.5	64	34 53.1	
United Kingdom	74	51	68.9	37 50.0	89	51 75.0		29	44 74.6	32 54.2
Germany	115		0.09		129	72 55.8		114	70 61.4	
Italy	41		43.9	9 22.0	49	20 40.8		39		15 38.5
France	53		52.8	19 35.8	47		16 34.0	32		8 25.0
Spain	35	15 4	42.9	13 37.1	33	19 57.6	16 48.5	37	25 67.6	19 51.4
Other	229		67.2	118 51.5	262	179 68.3	117 44.7	352	254 72.2	181 51.4
N./S. America	515	265	51.5	184 35.7	483	246 50.9	166 34.4	521	258 49.5	176 33.8
Canada	153	66	64.7	75 49.0	130	91 70.0	65 50.0	145		73 50.3
Mexico	84		35.7		98			94	34 36.2	
Argentina	32		0.09	16 45.7	59	11 37.9	7 24.1	45	31 68.9	21 46.7
Brazil	85		31.7	15 18.3	77	27 35.1	22 28.6	108	23 21.3	
Chile	23	ത	39.1	7 30.4	23	12 52.2	6 26.1	19	9 47.4	7 36.8
Colombia	28		53.6	6 21.4	21	10 47.6	6 28.6	20	11 55.0	8 40.0
Peru	9		70.0	5 50.0	12	8 66.7	6 50.0	Ξ	6 54.5	4 36.4
Other	100	28	58.0	39 39.0	105	56 53.3	37 35.2	6/	48 60.8	30 38.0

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

		1990			1991			1992			1993	
	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to
Region /country of origin	Pn.D. recipients	Stay in U.S. No. %	stay in U.S. No. %	Pn.D. recipients	Stay in U.S. No. %	Stay in U.S. No. %	Pn.D. recipients	Stay in U.S. No. %	Stay in U.S. No. %	Fn.D. recipients	Stay in U.S. No. %	Stay In U.S. No. %
						Social sciences	es.					
Asia	573	179 31.2	128 22.3	899	263 39.4	160 24.0	705	283 40.1	152 21.6	762	328 43.0	166 21.8
China	29	34 57.6	23 39.0	86	63 73.3		113	94 83.2	44 38.9	176	140 79.5	61 34.7
Taiwan	78	22 28.2	12 15.4	105		25 23.8	66	29 29.3	11 11.1	107		13 12.1
Japan	72	24 33.3	19 26.4	20	18 36.0	12 24.0	22	19 33.3	8 14.0	61	20 32.8	•
South Korea	204	36 17.6	26 12.7	251	55 21.9	33 13.1	268		28 10.4	232		13 5.6
India	9/	36 47.4	29 38.2	91		43 47.3	06			102		53 52.0
Other	84	27 32.1	19 22.6	82	30 35.3	16 18.8	78	30 38.5	18 23.1	84	29 34.5	15 17.9
Europe	175	88 50.3	65 37.1	229	126 55.0	97 42.4	238	149 62.6	102 42.9	247	124 50.2	85 34.4
Greece	18	10 55.6	6 33.3	29	12 41.4	8 27.6	24	15 62.5	8 33.3	29	18 62.1	11 37.9
United Kingdom	35		15 42.9	44			52	39 75.0	27 51.9	44		19 43.2
Germany	32	19 59.4	17 53.1	28		14 50.0	28	15 53.6	7 25.0	41	23 56.1	16 39.0
Italy	15	6 40.0	3 20.0	29	12 41.4	11 37.9	20		10 50.0	22		5 22.7
France	Ξ	4 36.4	3 27.3	=	6 54.5	6 54.5	12		5 41.7	12	3 25.0	2 16.7
Spain	14	6 42.9	6 42.9	18		9 50.0	23	12 52.2		25	5 20.0	4 16.0
Other	20	20 40.0	15 30.0	70	41 58.6	34 48.6	79	49 62.0	35 44.3	74	40 54.1	28 37.8
N./S. America	199	80 40.2	62 31.2	225	97 43.1	72 32.0	246	119 48.4	69 28.0	251	107 42.6	72 28.7
Canada	81	38 46.9	34 42.0	88	37 42.0	27 30.7	92	53 55.8		103	51 49.5	40 38.8
Mexico	14	5 35.7	2 14.3	26	13 50.0		30	9 30.0	2 6.7	28	9 32.1	5 17.9
Argentina	Ξ	5 45.5	5 45.5	16		5 31.3	27	12 44.4	5 18.5	12	4 33.3	1 8.3
Brazil	23	2 8.7	1 4.3	18	6 33.3		23			30		
Chile	17	5 29.4	3 17.6	13	3 23.1	3 23.1	14	5 35.7		13		2 15.4
Colombia	2	4 80.0	2 40.0	12		4 33.3	9	4 66.7	2 33.3	9	2 33.3	2 33.3
Peru	2	3 60.0	1 20.0	10		5 50.0	14	9 64.3	6 42.9	12		
Other	43	18 41.9	14 32 6	42	16 28 1	12 210	27	10 /0 6	2 16.0	77	00 76 00	14 000

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

Total Plan Ph.D. stay in recipients No. 845 408 208 186 118 21 77 33 241 51 111 80 90 37 224 124 27 52 52 36 31 11 7 11 7 11 6 50 21 239 103 86 40 226 239 103 239 103 226 239 103 226 239 103 226 239 103 226 24 226 226	Firm plans to						
Ph.D. stay in recipients No. 1845 408 485 408 485 408 421 411 80 37 422 42 422 422 422 422 422 422 422 422		Total	Plan to	Firm plans to	Total	Plan to	Firm plans to
recipients No. 845 408 845 408 118 21 118 21 111 80 37 224 124 27 27 33 11 19 11 11 11 11 11 11 11 11 11 11 11	stay in U.S.	Ph.D.	stay in U.S.	stay in U.S.	Ph.D.	stay in U.S.	stay in U.S.
845 408 208 186 118 21 77 33 241 51 111 80 90 37 224 124 842 27 52 36 11 7 11 6 50 21 14 6 50 21 50 21	No.	recipients	No.	No. %	recipients	No.	No. %
845 408 186 186 188 189 199 177 33 37 241 51 111 80 37 224 124 27 52 36 31 19 19 19 19 19 19 19 19 19 19 19 19 19			6	Social sciences			
208 186 118 21 77 33 241 51 111 80 90 37 90 37 224 124 24 27 11 7 1 14 6 50 21 239 103 86 40 26 8	204 24.1	841	389 46.3		829	379 45.7	216 26.1
118 21 241 51 111 80 90 37 224 124 24 27 42 27 31 19 11 7 11 7 14 6 50 21 239 103 86 40 239 103 24 8 11 7 14 6 50 21 14 7 16 8 17 7 18 8 18 8 19 8 10 8	81 38.9	177	150 84.7	69 39.0	191	154 80.6	88 46.1
241 51 111 80 90 37 90 37 224 124 24 27 25 36 31 11 7 11 7 11 7 11 7 11 7 11 11 7 11 11	9 7.6	122	30 24.6		116		6 5.2
241 51 111 80 90 37 224 124 24 8 42 27 52 36 31 19 11 7 11 7 14 6 50 21 239 103 86 40 26 8		74	32 43.2		6/	35 44.3	
224 124 27 224 124 27 224 124 27 22 36 36 21 239 103 28 8 40 22 28 8 8 40 22 28 8 8 22 28 8 22 28 8 22 28 8 22 28 28	26 10.8	242	48 19.8		221	41 18.6	22 10.0
224 124 27 42 27 36 31 19 19 19 19 19 19 19 19 19 19 19 19 19	50 45.0	135	97 71.9	59 43.7	131	91 69.5	61 46.6
224 124 27 27 36 31 19 11 7 11 7 239 103 86 40 21 14 10 28 8 40 21 14 10 26 8	16 17.8	91	32 35.2	18 19.8	91	31 34.1	20 22.0
24 8 42 27 36 36 31 11 19 11 11 23 103 86 40 86	82 36.6	244	148 60.7	101 41.4	266	139 52.3	91 34.2
42 27 36 36 31 19 11 17 11 19 50 21 239 103 86 40 28 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	5 20.8	26		7 26.9	22		9 40.9
52 36 31 19 11 7 14 6 50 21 239 103 86 40 28 8 14 10		46	33 71.7	26 56.5	20	35 70.0	24 48.0
31 19 11 7 11 7 14 6 50 21 239 103 86 40 28 8 14 10 26 8	29 55.8	42	29 69.0	22 52.4	41	23 56.1	15 36.6
11 7 7 50 21 239 103 86 40 28 8 8 8 8 104 104 10 10 10 10 10 10 10 10 10 10 10 10 10		23			30		
14 6 50 21 239 103 86 40 28 8 14 10	4 36.4	12			Ξ	5 45.5	2 18.2
50 21 239 103 86 40 28 8 14 10 26 8	6 42.9	12	8 66.7	7 58.3	21		
239 103 86 40 28 8 14 10 26 8	13 26.0	83			91	43 47.3	30 33.0
86 40 28 8 14 10 26 8	67 28.0	209	101 48.3	68 32.5	253	124 49.0	82 32.4
28 8 14 10 26 8	30 34.9	102	55 53.9	38 37.3	87	55 63.2	36 41.4
14 10 26 8	4 14.3	16	5 31.3		27		
26	7 50.0	13			14	5 35.7	
•	6 23.1	14	7	3 21.4	32		
7	1 9.1	7	0.0		o	2 22.2	1 11.1
9	3 37.5	14	2 14.3		15		2 13.3
Peru 12 4 33.3	3 25.0	o	3 33.3		14	11 78.6	8 57.1
Other 54 25 46.3	13 24.1	34	23 67.6	15 44.1	22	24 43.6	17 30.9

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

Region /country of origin		0661			1001			766			066	
country	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to	Total	Plan to	Firm plans to
	Ph.D. recipients	stay in U.S.	stay in U.S. No.	Ph.D. recipients	stay in U.S.	stay in U.S.	Ph.D. recipients	stay in U.S.	stay in U.S.	Ph.D. recipients	stay in U.S. No.	stay in U.S.
						2. □						
Asia	1.607	762 47.4	503 31.3	2.002	1,150 57.4	649 32.4	2.123	1.303 61.4	651 30.7	2.209	1.326 60.0	609 27.6
China	328			477	368 77.1	178 37.3	508			543		196 36.1
Taiwan	476	208 43.7	134 28.2	597		163 27.3	637	320 50.2	143 22.4	592	235 39.7	
Japan	17	5 29.4	4 23.5	29	7 24.1	6 20.7	25	6 24.0	3 12.0	23	6 26.1	1 4.3
South Korea	360	103 28.6	66 18.3	434		78 18.0	437		65 14.9	484	161 33.3	63 13.0
India	314	211 67.2	162 51.6	357	272 76.2	191 53.5	405	335 82.7	222 54.8	448	368 82.1	209 46.7
Other	112	56 50.0	39 34.8	108			Ξ	68 61.3		119	69 58.0	35 29.4
Europe	205	92 44.9	64 31.2	200	97 48.5	61 30.5	202	107 53.0	68 33.7	237	137 57.8	87 36.7
Greece	22	28 49.1	20 35.1	20	36 51.4	22 31.4	29	31 52.5	17 28.8	89	37 54.4	27 39.7
United Kingdom	15	10 66.7	7 46.7	15	10 66.7	6 40.0	17	14 82.4	11 64.7	18	16 88.9	12 66.7
Germany	15	5 33.3	4 26.7	∞	4 50.0	0.0 0	18	10 55.6	7 38.9	23	14 60.9	7 30.4
Italy	14	6 42.9	3 21.4	12	2 16.7	2 16.7	10	4 40.0	2 20.0	10	7 70.0	5 50.0
France	27	12 44.4	8 29.6	19	6 31.6	6 31.6	25	10 40.0	4 16.0	32	11 34.4	4 12.5
Spain	80	1 12.5	1 12.5	4	1 25.0	1 25.0	9	3 50.0	2 33.3	80	2 25.0	2 25.0
Other	69	30 43.5	21 30.4	72	38 52.8	24 33.3	29	35 52.2	25 37.3	78	50 64.1	30 38.5
N./S. America	168	75 44.6	56 33.3	170	96 56.5	67 39.4	160	84 52.5	55 34.4	179	83 46.4	45 25.1
Canada	41	22 53.7	16 39.0	54	32 59.3	24 44.4	46	27 58.7	20 43.5	42	26 61.9	18 42.9
Mexico	22	10 40.0	7 28.0	22	10 45.5	9 40.9	16	5 31.3	4 25.0	27	14 51.9	6 22.2
Argentina	12	6 50.0	4 33.3	12	9 75.0	6 50.0	14	9 64.3	5 35.7	10		3 30.0
Brazil	31	5 16.1	4 12.9	34	15 44.1	9 26.5	31	9 29.0	4 12.9	46	8 17.4	3 6.5
Chile	Ξ	4 36.4	3 27.3	80		2 25.0	10	2 20.0	2 20.0	5		1 20.0
Colombia	80	5 62.5	4 50.0	Ξ	8 72.7		6	6 66.7	4 44.4	80	3 37.5	3 37.5
Peru	9	3 50.0	3 50.0	7	7 100.0	4 57.1	2	5 100.0	3 60.0	10		3 30.0
Other	34	20 58.8	15 44.1	22	13 59.1	10 45.5	29	21 72.4	13 44.8	31	15 48.4	8 25.8

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Appendix table 2-37. Foreign doctoral recipients from U.S. universities who plan to stay in the United States, by field and region/country of origin: 1990-96

Total	Plan to stay in U.S. No. % No. % 1,521 63.6 603 91.9 306 45.7 12 26.1 143 33.3 402 83.8	Firm plans to stay in U.S. No. % 675 28.2 226 34.5 133 19.9 6 13.0 52 12.1 235 49.0 23 21.1	Total Ph.D. recipients 773 616 30 344 572 140	Plan to stay in U.S. No. % 1,708 69.0	Firm plans to stay in U.S. No. %	Total	Plan to	Firm plans to
Volea	<u> </u>	No. % 675 28.2 226 34.5 133 19.9 6 13.0 52 12.1 235 49.0 23 21.1			No. %		O I I i veta	/ 1 11 / 610
2,2						recipients	No. %	No. %
20 0 1 1 1			•		Engineering			
						2,508		1,085 43.3
					293 37.9	801	725 90.5	
			30 344 572 140	295 47.9	126 20.5	575	310 53.9	159 27.7
			344 572 140			32	8 25.0	4 12.5
			572 140 280			326		
			140	489 85.5	292 51.0	625	539 86.2	376 60.2
Oct	55 50.5		280			149	79 53.0	43 28.9
Europe 243	143 58.8	89 36.6)	187 66.8	104 37.1	210	136 64.8	95 45.2
		23 39.7	61	42 68.9	20 32.8	47	29 61.7	
United Kingdom 15	12 80.0	7 46.7	20	18 90.0		10		5 50.0
	19 65.5	11 37.9	37			16	10 62.5	8 50.0
		2 18.2	6	5 55.6	2 22.2	80	3 37.5	1 12.5
France 32	16 50.0	7 21.9	24		5 20.8	26		12 46.2
Spain 9	2 22.2	1 11.1	9	2 33.3	1 16.7	80		4 50.0
Other 89	58 65.2	38 42.7	123	85 69.1	54 43.9	92	67 70.5	43 45.3
N./S. America 201		51 25.4	170	70 41.2	42 24.7	215	102 47.4	
Canada 36	21 58.3	18 50.0	41		16 39.0	45		21 46.7
Mexico 30	11 36.7	4 13.3	26		6 23.1	37	15 40.5	8 21.6
Argentina7	6 85.7	5 71.4	7	4 57.1	4 57.1	80	7 87.5	4 50.0
Brazil 49	11 22.4	5 10.2	46		3 6.5	29	19 28.4	
	3 37.5	3 37.5	80	2 25.0	•	80	1 12.5	
Colombia 12	7 58.3	0.0 0	10	3 30.0	3 30.0	7	3 42.9	3 42.9
Peru 10	0.06 6	4 40.0	2	5 100.0	2 40.0	2	4 80.0	
Other 49	26 53.1	12 24.5	27	14 51.9	7 25.9	38	22 57.9	14 36.8

NOTES: Data Include foreign doctoral recipients with either permanent or temporary visas. Doctoral recipients who "plan to stay" think that they will locate in the United States; those with "firm plans" have a postdoctoral research appointment or academic, industrial, or other firm employment in the United States.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Earned Doctorates, unpublished tabulations, 1997.

See figure 2-19.

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Appendix table 2-38.

1990-91 Foreign doctoral recipients from U.S. universities working in the United States, by degree field and place of origin: 1992-95

		Pe	rcent working in	the United State	es
Degree field and place of origin	Foreign doctoral recipients	1992	1993	1994	1995
Total S&E fields	13,878	45	48	49	47
China	2,779	75	81	87	88
India	1,235	76	76	7	79
Japan		18	23	25	13
South Korea		17	14	13	11
Taiwan	*	46	48	45	42
England	´	48	55	55	59
Germany		30	2:	34	35
Greece		39	43	40	41
Canada		35	41	44	46
Mexico		26	28	28	30
Physical sciences		52	54	55	53
China	.'	78	84	88	90
India	•	70 70	73	76	73
		23	32	32	8
Japan South Korea		23	18	18	16
		23 51	47		
Taiwan				45 55	43
England		53	58	55	60
Germany		32	31	39	41
Greece		47	56	52	49
Canada		37	46	46	49
Mexico		22	32	30	30
Life sciences		38	42	46	45
China		64	72	86	85
India		71	61	73	73
Japan		23	32	32	8
South Korea		20	19	16	11
Taiwan	288	37	47	38	33
England	29	38	50	57	65
Germany		20	20	24	24
Greece	27	38	38	34	43
Canada	110	30	38	43	46
Mexico		20	18	21	25
Social sciences	2,188	27	28	28	28
China	133	64	70	69	69
India	135	53	55	56	54
Japan	99	15	16	19	14
South Korea	424	8	7	7	7
Taiwan		28	25	21	21
England		38	47	47	49
Germany		34	38	34	34
Greece		33	25	25	21
Canada		34	37	42	41
Mexico and Brazil		20	23	23	23
Engineering		52	54	55	53
China	*	80	87	91	91
India		86	87	89	89
Japan		17	20	23	20
South Korea		18	14	11	10
		50	53	51	48
Taiwan			53 73		
England		73		73 26	73 26
Germany		33	26	26	26
Greece		36	40	38	41
Canada		43	42	43	49
Mexico	42	44	44	42	42

NOTES: Data are for foreign doctoral recipients with temporary visas only. Physical sciences include mathematics and computer sciences. Social sciences include psychology, sociology, and other social sciences.

SOURCE: M.G. Finn, Stay Rates of Foreign Doctorate Recipients From U.S. Universities, 1995 (Oak Ridge, TN: Oak Ridge Institute for Science and Education, 1997).

Appendix table 2-39. **Postdoctoral appointments in science and engineering, by citizenship status: 1988-95**

Field	1988	1989	1990	1991	1992	1993	1994	1995
	All p	ostdoctora	al appointm	ents				
Total, all surveyed fields ^a	26,083	27,878	29,515	30,800	32,682	34,263	36,301	35,379
Total, science and engineering fields	19,687	20,864	21,770	22,808	23,825	24,599	25,727	25,995
Total sciences	18,002	18,952	19,831	20,565	21,474	22,165	23,137	23,367
Total engineering	1,685	1,912	1,939	2,243	2,351	2,434	2,590	2,628
		To U.S.	citizens					
Total, all surveyed fields ^a	14,392	14,826	15,090	15,097	15,764	16,684	17,939	18,002
Total, science and engineering fields	10,423	10,654	10,651	10,775	11,154	11,591	12,433	12,778
Total sciences	9,838	10,003	10,043	10,130	10,393	10,750	11,429	11,791
Total engineering	585	651	608	645	761	841	1,004	987
		To non-U.	S. citizens					
Total, all surveyed fields ^a	11,691	13,052	14,425	15,703	16,918	17,579	18,362	17,377
Total, science and engineering fields	9,264	10,210	11,119	12,033	12,671	13,008	13,294	13,217
Total sciences	8,164	8,949	9,788	10,435	11,081	11,415	11,708	11,576
Total engineering	1,100	1,261	1,331	1,598	1,590	1,593	1,586	1,641

^aSurvey includes all science, engineering, and health fields.

SOURCE: National Science Foundation, Science Resources Studies Division, *Graduate Students and Postdoctorates in Science and Engineering, Fall 1995, NSF* 97-312 (Arlington, VA: 1997).

Appendix table 2-40. Foreign-born S&E faculty in U.S. higher education, by teaching field and region of origin: 1993

Region of origin	Total S&E	Physical sciences	Life sciences	Math & computer sciences	Social sciences	Engineering
		Number				
Total S&E faculty	242,812	37,693	59,654	45,545	72,910	27,010
U.S. origin	193,606	29,550	51,382	33,122	62,522	17,029
Foreign origin	49,206	8,143	8,273	12,423	10,388	9,980
Asia	22,608	3,630	4,081	5,702	3,868	5,327
Europe	11,693	2,815	2,202	2,900	2,085	1,692
North America	2,206	330	473	261	958	185
Central America	671	25	188	59	139	261
Caribbean	747	128	134	87	366	32
South America	2,621	128	298	408	813	964
Africa	2,621	128	298	408	813	964
Oceania	499	40	103	115	140	101
Abroad, not specified	6,462	1,000	308	2,356	1,589	1,210
		Percent				
Total S&E faculty	100.0	100.0	100.0	100.0	100.0	100.0
U.S. origin	79.7	78.4	86.1	72.7	85.8	63.1
Foreign origin	20.3	21.6	13.9	27.3	14.2	36.9
Asia	9.3	9.6	6.8	12.5	5.3	19.7
Europe	4.8	7.5	3.7	6.4	2.9	6.3
North America	0.9	0.9	0.8	0.6	1.3	0.7
Central America	0.3	0.1	0.3	0.1	0.2	0.0
Caribbean	0.3	0.3	0.2	0.2	0.5	0.1
South America	0.6	0.1	0.7	1.1	0.5	0.8
Africa	1.1	0.3	0.5	0.9	1.1	3.6
Oceania	0.2	0.1	0.2	0.3	0.2	0.4
Abroad, not specified	2.7	2.7	0.5	5.2	2.2	4.5

NOTES: Data include scientists and engineers whose first job is in S&E postsecondary teaching at four-year college and universities in the United States. Data exclude scientists and engineers who teach in S&E fields in two-year or community colleges, or who teach as a secondary job.

SOURCE: National Science Foundation, Science Resources Studies Division, SESTAT database, unpublished tabulations.

See figure 2-20 and text table 2-11.

Science & Engineering Indicators - 1998

Appendix table 2-41. Foreign-born female S&E faculty in U.S. higher education, by teaching field and region of origin: 1993

Region of origin	Total S&E	Physical sciences	Life sciences	Math & computer sciences	Social sciences	Engineering
Total foreign-born female S&E faculty	9,897	1,712	2,400	2,346	2,777	662
Asia	4,509	873	1,118	1,157	1,061	300
Europe	1,899	368	547	398	405	181
North America	368	29	185	7	138	9
Central America	49	0	8	8	29	4
Caribbean	225	24	85	0	116	0
South America	333	27	160	19	28	99
Africa	260	10	81	77	66	26
Oceania	123	0	9	0	105	9
Abroad, not specified	2,131	381	207	680	829	34

NOTES: Data include scientists and engineers whose first job is in S&E postsecondary teaching at four-year college and universities in the United States. Data exclude scientists and engineers who teach in S&E fields in two-year or community colleges, or who teach as a secondary job.

SOURCE: National Science Foundation, Science Resources Studies Division, SESTAT database, unpublished tabulations.

Appendix table 2-42. Major places of origin for foreign-born S&E faculty in U.S. higher education, by field: 1993

Place of origin	Total S&E	Physical sciences	Life sciences	Math & computer sciences	Social sciences	Engineering
Total S&E faculty	242,812	37,693	59,654	45,545	72,910	27,010
		Total				
Total S&E faculty from						
major places of origin	23,762	4,706	3,754	5,394	4,589	5,319
India	5,696	597	796	1,648	1,032	1,6237
China	4,263	970	773	1,261	386	873
United Kingdom	3,149	1,076	476	380	487	730
Taiwan	2,491	507	350	688	234	712
Canada	2,206	330	473	260	958	185
South Korea	2,163	511	311	426	571	344
Germany	1,604	410	400	236	553	5
Iran	1,369	113	101	268	269	618
Greece	821	192	74	227	99	229
		Female				
Total S&E faculty from						
major places of origin	4,316	984	1,152	947	939	294
India	1,168	125	241	423	274	105
China	1,031	371	309	212	52	87
United Kingdom	251	57	87	23	73	11
Taiwan	638	214	128	228	65	3
Canada	368	29	185	7	138	9
South Korea	201	30	16	14	141	0
Germany	289	64	105	30	90	0
Iran	143	17	7	10	98	11
Greece	227	77	74	0	8	68

NOTES: Data include scientists and engineers whose first job is in S&E postsecondary teaching at four-year college and universities in the United States. Data exclude scientists and engineers who teach in S&E fields in two-year or community colleges, or who teach as a secondary job.

SOURCE: National Science Foundation, Science Resources Studies Division, SESTAT database, unpublished tabulations.

See text table 2-11.

Science & Engineering Indicators – 1998

Appendix table 2-43. S&E doctoral degrees earned by Asian students at U.S. universities, by place of origin: 1986-95

	Cumulative										
Place of origin	1986-95	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total	44,931	2,139	2,473	2,762	3,099	4,315	5,239	5,725	5,943	6,549	6,687
China	14,088	198	293	480	620	1,150	1,793	2,045	2,227	2,531	2,751
Hong Kong	952	73	87	81	93	94	121	109	109	95	90
India	7,554	469	503	520	536	711	752	861	933	1,065	1,204
Japan	1,276	111	83	104	106	147	125	132	132	182	154
South Korea	8,821	402	549	621	753	979	1,114	1,126	1,123	1,150	1,004
Taiwan	10,276	709	790	786	857	1,012	1,127	1,242	1,213	1,301	1,239
Thailand	956	109	95	98	76	111	93	87	77	97	113
Other Asia	1,008	68	73	72	58	111	114	123	129	128	132

NOTE: Data include foreign students with either temporary or permanent visas.

SOURCE: National Science Foundation, Science Resources Studies Division, Selected Data on Science and Engineering Doctorate Awards: 1995, NSF 96-303 (Arlington, VA: 1996).

See text table 2-12.

Appendix table 3-1. Number, education and employment status, and median income of 1993 and 1994 bachelor's and master's degree recipients, by degree field: 1995

			No	t full-time stude	nt	
Degree field	Graduates (thousands) ^a	Full-time student	Employed in S&E occupation	Employed in non-S&E occupation	Unemployed	Median salary ^b
	Bachelo	or's degree re	cipients			
TOTAL SCIENCE & ENGINEERING	700.1	23	19	52	6	25,000
Total science	581.7	25	10	59	6	22,900
Mathematics & computer sciences	69.2	13	32	51	4	30,000
Life sciences	121.6	37	10	47	5	22,000
Physical sciences	33.2	39	27	30	4	25,000
Social sciences	357.8	21	5	67	7	21,000
Total engineering	118.4	15	62	20	4	33,500
Aerospace	4.4	25	43	29	3	30,000
Chemical	9.6	22	58	14	6	37,800
Civil & architectural	18.0	13	68	17	3	30,000
Electrical, electronics, computer						
& communications	38.6	12	64	21	4	35,000
Industrial	6.4	10	59	28	3	34,000
Mechanical	28.9	13	66	17	4	34,000
Other	12.5	25	50	21	3	32,000
	Maste	r's degree rec	ipients			
TOTAL SCIENCE & ENGINEERING	146.3	24	43	28	5	39,000
Total science	99.7	26	32	36	5	35,000
Mathematics & computer sciences	24.3	14	54	28	4	43,200
Life sciences	15.0	36	30	29	5	31,200
Physical sciences	9.7	39	41	16	5	35,000
Social sciences	50.7	27	21	46	6	30,000
Total engineering	46.6	19	65	11	4	44,000
Aerospace	1.7	28	56	14	2	43,600
Chemical	1.8	25	67	5	3	44,000
Civil & architectural	6.1	13	77	7	3	39,500
Electrical, electronics, computer						
& communications	16.4	21	65	9	5	46,000
Industrial	3.0	9	66	23	2	44,000
Mechanical	7.4	20	67	9	3	43,00
Other	10.1	20	59	16	5	45,000

NOTES: For graduates with more than one eligible degree at the same level (bachelor's/master's), the most recent degree at that level was used. Details may not sum to totals because of rounding. Percentages were calculated on unrounded data. Education and employment status are as of April 1995.

SOURCE: National Science Foundation, Science Resources Studies Division, National Survey of Recent College Graduates, 1995.

alnoludes people who received a bachelor's or master's degree in science or engineering from a U.S. college or university between July 1992 and June 1994.

^bSalary data are provided only for graduates who are employed full time; data for self-employed and full-time students are not included. Median salaries are rounded to the nearest hundred dollars.

Appendix table 3-2. Employed 1993 and 1994 S&E bachelor's and master's degree recipients, by degree field and sector of employment: 1995

				Sector o	f employment	(percentage	es) ^a	
Degree field	Total employed (thousands)	4-year college & university	Other educational institution	Private for- profit	Self- employed	Private not- for-profit	Federal Government	State & local government
		Back	nelor's degree i	recipients				
Total science & engineering	585.6	13	9	59	2	6	4	6
Total science	476.7	14	10	56	3	7	4	7
Total engineering	108.9	11	1	75	2	1	7	4
		Ма	ster's degree r	ecipients				
Total science & engineering	128.4	23	9	47	2	6	7	6
Total science	86.0	26	12	38	2	9	5	7
Total engineering	42.4	17	1	66	1	1	10	4

NOTES: For graduates with more than one eligible degree at the same level (bachelor's/master's), the most recent degree at that level was used. Details may not sum to totals because of rounding. Percentages were calculated on unrounded data.

SOURCE: National Science Foundation, Science Resources Studies Division, National Survey of Recent College Graduates, 1995.

^aThis is the sector of employment in which the respondent was working on his or her primary job held on April 15, 1995. People working in four-year colleges and universities or university-affiliated medical schools or research organizations were classified as employed in the "four-year college and university" sector. Those working in elementary, middle, secondary, or two-year colleges or other educational institutions were categorized in the "other educational" sector. Those reporting that they were self-employed but in an incorporated business were classified in the "private for-profit" sector.

Appendix table 3-3. Employment status of scientists and engineers, by broad occupation and highest degree received: 1995

Occupation	Total	Employed	Unemployed
All degree	recipients		
All S&E occupations	3,256,200	3,185,600	70,600
Computer and math scientists	966,200	949,500	16,800
Life scientists	311,500	305,300	6,200
Physical scientists	281,800	274,300	7,500
Social scientists	321,400	317,500	3,900
Engineers	1,375,200	1,339,000	36,200
Bachelor's de	gree recipient	s	
All S&E occupations	1,883,400	1,844,000	39,400
Computer and math scientists	635,300	625,000	10,400
Life scientists	123,900	121,500	2,400
Physical scientists	131,000	128,100	2,900
Social scientists	61,600	60,600	1,000
Engineers	931,500	908,800	22,800
Master's deg	ree recipients	1	
All S&E occupations	915,800	892,700	23,000
Computer and math scientists	273,600	268,000	5,600
Life scientists	65,200	64,000	1,200
Physical scientists	69,800	67,200	2,700
Social scientists	138,000	135,800	2,300
Engineers	369,100	357,900	11,300
Ph.D. degre	e recipients		
All S&E occupations	425,700	418,300	7,500
Computer and math scientists	54,600	53,800	800
Life scientists	104,500	102,400	2,000
Physical scientists	80,600	78,900	1,800
Social scientists	113,900	113,300	700
Engineers	72,100	69,900	2,200
Other professiona	l degree recip	oients	
All S&E occupations	31,300	30,600	700
Computer and math scientists	2,700	2,700	_
Life scientists	17,900	17,400	600
Physical scientists	300	200	100
Social scientists	7,900	7,900	-
Engineers	2,500	2,500	-

^{- =} weighted value of less than 50

See figure 3-3.

Appendix table 3-4. Number of employed scientists and engineers, by occupation and highest degree received: 1995

Occupation	Total	Bachelor's degree	Master's degree	Ph.D. degree	Other professional degree
All S&E occupations	3,185,600	1,844,000	892,700	418,300	30,600
Computer and math scientists	949,500	625,000	268,000	53,800	2,700
Computer and information scientists	839,600	595,200	219,800	22,100	2,500
Mathematicians	37,900	16,300	14,000	7,600	_
Postsecondary teachers	72,000	13,500	34,200	24,100	200
Life scientists	305,300	121,500	64,000	102,400	17,400
Agricultural scientists	43,400	24,700	9,300	9,300	100
Biological scientists	168,600	69,700	32,800	57,900	8,200
Environmental life scientists	20,100	13,400	5,800	900	_
Postsecondary teachers	73,200	13,600	16,200	34,400	9,000
Physical scientists	274,300	128,100	67,200	78,900	200
Chemists, except biochemists	111,400	65,300	20,200	25,900	100
Earth scientists	70,700	36,100	24,300	10,400	_
Physicists and astronomers	29,000	7,100	7,700	14,100	_
Other physical scientists	17,000	9,300	5,100	2,600	100
Postsecondary teachers	46,200	10,300	9,900	25,900	_
Social scientists	317,500	60,600	135,800	113,300	7,900
Economists	33,100	10,900	15,100	7,000	100
Political scientists	8,900	5,100	2,600	1,200	_
Psychologists	167,200	25,400	88,700	48,200	4,900
Sociologists and anthropologists	16,000	7,800	5,200	3,000	· _
S&T historians and other social scientists	12,600	3,800	4,900	3,100	900
Postsecondary teachers	79,700	7,600	19,300	50,800	2,000
Engineers	1,339,000	908,800	357,900	69,900	2,500
Aerospace engineers	72,800	42,600	25,900	4,200	100
Chemical engineers	71,100	46,100	19,200	5,800	_
Civil and architectural engineers	198,900	143,400	51,000	3,900	600
Electrical and related engineers	357,400	241,000	102,000	13,200	1,200
Industrial engineers	69,600	52,400	16,400	800	
Mechanical engineers	255,100	191,600	55,000	8,100	300
Other engineers	282,800	186,300	79,900	16,400	200
Postsecondary teachers	31,300	5,300	8,400	17,500	_

⁻⁼ weighted value of less than 50; S&T = science and technology

See text table 3-11.

Appendix table 3-5. Number of employed scientists and engineers, by occupation and degree field: 1995

Occupation	All fields	Math & computer science	Life sciences	Physical sciences	Social sciences	Engineering	Non-S&E fields
All S&E occupations	3,185,600	446,500	297,200	312,900	384,400	1,193,700	550,800
Computer and math scientists	949,500	406,600	21,700	36,900	88,500	145,700	250,000
Computer and information scientists	839,600	345,300	19,100	33,200	80,500	138,000	223,600
Mathematicians	37,900	17,500	1,800	2,300	5,800	3,200	7,200
Postsecondary teachers	72,000	43,900	700	1,400	2,200	4,500	19,300
Life scientists	305,300	1,400	217,100	19,500	14,400	3,800	49,100
Agricultural scientists	43,400	300	33,300	1,600	1,700	500	6,000
Biological scientists	168,600	1,000	120,300	15,000	8,000	2,700	21,500
Environmental life scientists	20,100	_	14,100	400	1,600	100	3,800
Postsecondary teachers	73,200	100	49,400	2,400	3,100	400	17,800
Physical scientists	274,300	4,800	33,400	200,800	7,500	14,200	13,600
Chemists, except biochemists	111,400	1,100	17,700	80,900	1,100	4,600	6,100
Earth scientists	70,700	1,700	4,600	56,300	2,000	4,100	2,000
Physicists and astronomers	29,000	600	700	23,200	100	2,800	1,600
Other physical scientists	17,000	500	6,400	4,500	2,700	1,400	1,500
Postsecondary teachers	46,200	900	4,100	35,900	1,600	1,200	2,400
Social scientists	317,500	1,700	3,500	1,100	253,100	1,700	56,500
Economists	33,100	1,000	700	200	21,900	1,100	8,200
Political scientists	8,900	_	_	_	8,700	_	100
Psychologists	167,200	100	700	300	137,100	200	28,800
Sociologists and anthropologists	16,000	200	500	400	14,200	100	600
S&T historians & other social scientists	12,600	200	600	100	7,900	200	3,600
Postsecondary teachers	79,700	200	1,000	100	63,300	200	15,000
Engineers	1,339,000	32,000	21,500	54,600	20,900	1,028,400	181,700
Aerospace engineers	72,800	2,700	300	4,100	1,000	52,400	12,200
Chemical engineers	71,100	100	900	4,300	_	59,100	6,600
Civil and architectural engineers	198,900	1,000	800	1,800	2,500	175,300	17,500
Electrical and related engineers	357,400	14,900	2,000	12,900	4,500	274,500	48,600
Industrial engineers	69,600	2,100	1,300	3,100	4,500	40,700	18,000
Mechanical engineers	255,100	1,900	600	2,700	700	215,500	33,600
Other engineers	282,800	8,500	15,400	24,400	7,400	184,300	42,800
Postsecondary teachers	31,300	700	200	1,200	200	26,600	2,500

⁻ = weighted value of less than 50; S&T = science and technology

See text table 3-12.

Appendix table 3-6. Employed scientists and engineers, by age group and highest degree received: 1995

Age group	Total	Bachelor's degree	Master's degree	Ph.D. degree	Other professional degree
Total	3,185,600	1,844,000	892,700	418,300	30,600
		Percentages			
Under 25	2.3	3.7	0.6	0.1	0.1
25-29	11.1	14.8	8.2	1.3	2.6
30-34	17.3	19.1	16.2	12.0	9.0
35-39	18.1	18.4	17.9	17.4	20.1
40-44	16.0	15.1	17.4	16.5	16.5
45-49	14.0	12.0	16.3	17.6	20.9
50-54	9.1	7.0	10.8	14.7	8.6
55-59	6.0	4.5	7.1	10.1	6.8
60-64	3.5	3.1	3.4	5.4	7.7
Over 64	2.5	2.4	2.1	5.0	7.8

See figure 3-4.

Appendix table 3-7. Number of employed scientists and engineers, by sector of employment and broad occupation: 1995

Sector	Total	Computer & math scientists	Life scientists	Physical scientists	Social scientists	Engineers
	A	II degree recipien	ts			
Total, all sectors	3,185,600	949,500	305,300	274,300	317,500	1,339,000
Four-year college & university	291,100	41,000	84,300	51,100	71,900	42,800
Other educational institution	275,200	83,000	64,700	28,500	67,600	31,400
Private for-profit	1,970,300	683,200	75,600	138,600	57,600	1,015,300
Self-employed	113,800	23,600	7,400	6,500	42,600	33,800
Private not-for-profit	91,000	27,600	11,000	5,600	33,700	13,200
Federal Government	252,400	53,300	37,700	27,600	17,100	116,600
State & local government	191,700	37,900	24,600	16,400	27,000	85,900
	Bach	elor's degree reci	pients			
Total, all sectors	1,844,000	625,000	121,500	128,100	60,600	908,800
Four-year college & university	63,400	10,500	20,500	11,800	10,800	9,800
Other educational institution	85,900	34,700	20,000	8,700	8,400	14,200
Private for-profit	1,324,800	482,800	39,200	78,800	16,100	708,000
Self-employed	48,800	16,000	3,600	3,100	2,800	23,400
Private not-for-profit	41,100	19,500	4,300	2,200	8,700	6,300
Federal Government	150,400	35,100	17,100	12,400	5,700	80,100
State & local government	129,500	26,400	16,800	11,200	8,100	66,900
	Mas	ter's degree recip	ients			
Total, all sectors	892,700	268,000	64,000	67,200	135,800	357,900
Four-year college & university	45,800	10,000	6,700	7,000	11,400	10,800
Other educational institution	128,800	39,900	19,900	12,800	42,000	14,200
Private for-profit	524,300	179,400	16,700	32,600	26,100	269,600
Self-employed	39,500	6,200	2,100	2,100	21,000	8,100
Private not-for-profit	31,700	6,500	2,200	1,000	16,900	5,200
Federal Government	70,800	15,400	10,600	7,400	5,600	31,800
State & local government	51,800	10,600	5,900	4,400	12,800	18,200
	Ph	.D. degree recipie	nts	•	•	•
Total, all sectors	418,300	53,800	102,400	78,900	113,300	69,900
Four-year college & university	181,300	20,400	56,800	32,400	49,700	22,100
Other educational institution	45,400	8,300	12,900	7,100	14,100	3,000
Private for-profit	114,600	18,700	17,800	27,200	14,900	36,000
Self-employed	23,100	1,500	1,300	1,300	16,900	2,100
Private not-for-profit	16,300	1,600	3,900	2,500	6,700	1,700
Federal Government	28,400	2,500	8,300	7,700	5,600	4,300
State & local government	9,300	900	1,600	700	5,400	700
		fessional degree			· · · · · · · · · · · · · · · · · · ·	
Total, all sectors	30,600	2,700	17,400	200	7,900	2,500
Four-year college & university	600	-	400		, -	100
Other educational institution	15,100	100	11,900	_	3,100	-
Private for-profit	6,600	2,200	2,000	100	600	1.600
Self-employed	2,300	_,	300	-	1,900	100
Private not-for-profit	2,000	_	700	_	1,300	-
Federal Government	2,800	300	1,700	100	300	400
State & local government	1,200	-	300	-	800	100
Ciato a local government	1,200					100

⁻ = weighted value of less than 50

Appendix table 3-8. **Median annual salaries of employed scientists and engineers, by occupation and highest degree received: 1995** (Dollars)

Occupation	Total	Bachelor's degree	Master's degree	Ph.D. degree	Other professional degree
All S&E occupations	50,000	48,000	53,000	58,000	69,000
Computer and math scientists	50,000	49,000	55,000	58,000	63,000
Computer and information scientists	50,000	49,000	57,000	65,000	63,000
Mathematicians	53,000	47,700	55,200	65,000	NA
Postsecondary teachers	41,000	30,000	32,300	50,500	44,000
Life scientists	42,000	35,000	40,000	53,000	100,000
Agricultural scientists	41,000	38,800	36,000	54,000	44,000
Biological scientists	40,000	31,600	40,900	52,000	90,000
Environmental life scientists	40,000	37,000	43,000	59,000	NA
Postsecondary teachers	49,200	28,000	35,000	54,600	100,000
Physical scientists	47,000	40,000	48,000	60,000	24,000
Chemists, except biochemists	47,000	40,000	50,000	64,100	52,000
Earth scientists	45,000	40,000	49,000	62,500	NA
Physicists and astronomers	55,800	42,000	52,000	65,000	NA
Other physical scientists	43,900	37,400	48,000	63,500	24,000
Postsecondary teachers	45,000	15,000	42,000	50,000	17,000
Social scientists	43,000	27,000	39,000	53,000	49,000
Economists	53,500	42,000	59,900	77,000	120,000
Political scientists	33,000	27,200	35,000	61,000	NA
Psychologists	40,000	22,000	37,000	55,000	49,000
Sociologists and anthropologists	32,000	27,000	32,000	50,000	NA
S&T historians and other social scientists	40,000	27,000	39,300	53,700	48,500
Postsecondary teachers	47,000	25,200	36,000	50,000	48,000
Engineers	54,000	50,000	59,000	65,000	50,000
Aerospace engineers	58,000	55,000	60,000	70,000	22,000
Chemical engineers	60,000	55,000	63,000	70,000	NA
Civil and architectural engineers	50,000	48,000	55,000	60,000	50,000
Electrical and related engineers	56,000	52,800	62,000	70,300	53,000
Industrial engineers	50,000	48,000	51,600	66,250	NA
Mechanical engineers	52,000	50,000	56,000	62,000	50,000
Other engineers	53,000	50,000	60,000	65,000	150,000
Postsecondary teachers	54,000	40,000	42,000	60,000	48,000

NA = not available; S&T = science and technology

NOTE: Median annual salaries are for full-time employees only.

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates.

See figure 3-5.

Appendix table 3-9.

Median annual salaries of employed scientists and engineers, by occupation and degree field: 1995 (Dollars)

Occupation	All fields	Math & computer sciences	Life sciences	Physical sciences	Social sciences	Engineering	Non-S&E fields
All S&E occupations	50,000	50,000	41,000	50,000	45,000	53,500	50,000
Computer & math scientists	50,000	50,000	45,000	55,000	48,500	54,800	49,000
Computer & information scientists	50,000	50,500	45,000	55,000	48,500	54,000	50,000
Mathematicians	53,000	55,000	52,000	55,000	50,000	60,000	49,700
Postsecondary teachers	41,000	42,000	51,500	47,400	35,000	51,000	34,000
Life scientists	42,000	50,000	40,500	40,000	42,000	35,000	48,000
Agricultural scientists	41,000	50,000	40,000	68,000	42,000	37,500	43,000
Biological scientists	40,000	48,700	39,000	37,500	37,000	31,300	45,000
Environmental life scientists	40,000	NA	38,900	45,000	44,500	10,000	37,000
Postsecondary teachers	49,200	60,000	46,800	51,400	48,900	64,000	63,900
Physical scientists	47,000	45,000	37,500	49,200	47,000	48,000	40,000
Chemists, except biochemists	47,000	34,000	35,500	50,000	74,000	44,000	43,000
Earth scientists	45,000	52,000	40,000	47,500	40,000	50,000	38,600
Physicists & astronomers	55,800	58,000	110,000	57,000	52,500	48,000	52,000
Other physical scientists	43,900	39,600	37,400	51,300	47,000	55,800	37,000
Postsecondary teachers	45,000	57,300	34,900	48,000	67,000	43,000	39,000
Social scientists	43,000	41,000	48,200	46,000	42,000	60,000	45,000
Economists	53,500	45,000	60,000	46,000	55,000	67,000	49,300
Political scientists	33,000	NA	28,000	46,000	32,500	NA	40,000
Psychologists	40,000	51,000	30,000	15,500	40,000	NA	40,000
Sociologists & anthropologists	32,000	NA	50,000	50,000	31,700	NA	24,800
S&T historians & other social scientists	40,000	20,000	26,500	53,200	39,300	34,000	46,000
Postsecondary teachers	47,000	80,000	48,200	75,000	46,200	40,000	48,000
Engineers	54,000	54,000	48,500	55,500	47,000	53,500	55,000
Aerospace engineers	58,000	62,900	64,000	67,000	70,000	57,000	58,000
Chemical engineers	60,000	58,000	50,000	59,000	41,000	60,000	65,000
Civil & architectural engineers	50,000	60,000	48,500	48,000	43,000	50,000	55,000
Electrical & related engineers	56,000	53,400	50,000	58,000	65,000	55,900	58,000
Industrial engineers	50,000	51,700	60,000	52,000	47,000	48,400	50,000
Mechanical engineers	52,000	50,000	52,000	53,000	48,000	52,000	54,000
Other engineers	53,000	53,900	45,000	55,000	43,500	53,000	55,000
Postsecondary teachers	54,000	60,000	66,100	63,000	53,500	54,000	42,000

NA = not available; S&T = science and technology

NOTE: Median annual salaries are for full-time employees only.

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates.

Appendix table 3-10. Number of employed scientists and engineers, by occupation, sex, and race/ethnicity: 1995

Occupation	Total	Male	Female	White	Black	Hispanic	Asian/Pacific Islander	Native American
All S&E occupations	3,185,600	2,472,100	713,500	2,673,700	107,500	90,100	304,600	8,000
Computer and math scientists	949,500	674,500	275,000	784,900	39,300	22,800	100,200	1,600
Computer and information scientists	839,600	602,700	236,900	694,100	33,100	20,500	90,400	1,200
Mathematicians	37,900	25,300	12,500	31,600	2,500	009	2,700	100
Postsecondary teachers	72,000	46,500	25,500	59,200	3,600	1,700	7,100	300
Life scientists	305,300	199,400	105,900	257,200	9,700	8,500	29,000	200
Agricultural scientists	43,400	32,300	11,100	37,800	1,500	1,600	2,400	I
Biological scientists	168,600	100,700	006'29	137,100	4,800	4,700	21,500	400
Environmental life scientists	20,100	17,400	2,700	19,500	100	300	ı	100
Postsecondary teachers	73,200	49,100	24,100	62,900	3,300	1,900	5,100	100
Physical scientists	274,300	215,200	59,100	232,600	7,800	0,800	26,200	800
Chemists, except biochemists	111,400	82,500	29,000	88,800	5,400	2,300	14,600	400
Earth scientists	70,700	58,100	12,600	64,100	200	2,100	3,500	300
Physicists and astronomers	29,000	25,700	3,300	24,900	300	400	3,300	ı
Other physical scientists	17,000	12,400	4,600	15,200	300	009	006	ı
Postsecondary teachers	46,200	36,600	009'6	39,600	1,100	1,400	4,000	100
Social scientists	317,500	159,000	158,500	277,900	16,500	9,800	11,800	1,500
Economists	33,100	23,900	9,200	28,200	1,200	1,600	1,900	100
Political scientists	8,900	4,900	4,000	7,200	300	009	800	ı
Psychologists	167,200	65,700	101,600	150,200	8,400	4,600	3,100	006
Sociologists and anthropologists	16,000	8,400	7,700	14,600	009	200	009	100
S&T historians and other social scientists	12,600	6,300	6,300	10,600	1,100	300	200	ı
Postsecondary teachers	79,700	49,900	29,800	67,200	4,900	2,400	4,700	400
Engineers	1,339,000	1,224,000	115,000	1,121,000	34,200	42,200	137,300	3,400
Aerospace engineers	72,800	68,300	4,500	61,900	1,700	3,000	5,800	300
Chemical engineers	71,100	62,200	8,900	58,600	2,200	2,400	7,900	ı
Civil and architectural engineers	198,900	180,900	18,000	164,600	3,600	7,300	22,900	400
Electrical and related engineers	357,400	335,200	22,300	285,400	11,500	12,900	46,700	006
Industrial engineers	69,600	009'09	9,000	60,300	3,100	2,100	3,700	400
Mechanical engineers	255,100	240,300	14,800	218,700	2,600	6,800	22,500	800
Other engineers	282,800	247,500	35,300	248,000	2,600	6,500	22,100	009
Postsecondary teachers	31,300	28,900	2,400	23,500	006	1,100	5,700	100

^{- =} weighted value of less than 50; S&T = science and technology

NOTE: Total includes 1,700 persons whose race/ethnicity category was reported as "other."

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates.

See figure 3-6 and text table 3-14.

Appendix table 3-11. Percentage distribution of employed scientists and engineers, by highest degree received, sex, and race/ethnicity: 1995

Name of the comparitors (compared as comparitors (compared as comparitors (compared as comparitors (compared as comparitors) 1.65,000 2.472,100 7.15,500 2.673,700 7.15,500 2.673,700	Occupation	Total	Male	Female	White	Black	Hispanic	Asian/Pacific Islander	Native American
3,165,600 2,472,100 713,500 2,673,700 107,500 90,100 304,600 8,0 9,8 8,7 38,5 29,4 36,6 25,3 32,9 46,1 17,7 46,8 45,1 45,1 46,8 45,1 45,1 46,8 45,1 45,1 46,8 45,1 45,1 45,1 46,8 45,1 45,1 45,1 46,8 45,1 45,1 45,1 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,9 46,4 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,8 46,9 46,9 46,9 46,9 4				degree recipient	s				
29.8 27.3 38.5 29.4 36.6 25.3 32.9 8.6 8.7 8.3 8.7 7.3 7.5 8.4 9.5 8.6 8.7 8.3 8.7 7.3 7.5 8.6 8.9 10.0 6.4 22.2 10.4 15.3 10.9 3.9 10.0 6.4 16.1 41.0 3.1 46.8 45.1 42.0 1.646,700 378.300 1.585,200 70,400 54,900 127,600 47.1 3.9 49.5 1.585,200 70,400 54,900 127,600 47.7 52.0 6.9 6.4 8.9 7.0 6.7 6.7 6.7 5.5 5.0 6.9 6.4 8.9 7.0 7.6 5.5 5.0 5.2 6.9 5.5 5.0 5.2 8.3 5.6 21.1 4.9 3.7 4.8 5.0 5.0 5.0 5.0 5.0 5.		3,185,600	2,472,100	713,500	2,673,700	107,500	90,100	304,600	8,000
9.6 8.1 14.8 9.6 9.0 9.4 9.5 10.0 6.4 22.2 10.4 15.3 10.9 3.8 Bachelor's degree recipients Bachelor's degree recipients 1.84,000 1.465,700 378,300 1.585,205 70,406 54,900 127,600 4,71 6.6 5.1 12.3 6.7 7.0 7.6 5.5 5.9 6.9 5.1 12.3 6.7 7.0 7.7 5.2 8.9 Master's degree recipients Master's degree recipients 7.2 7.4 9.8 4.8 5.5 5.9 1.5 1.2 7.7 3.9 4.8 5.5 5.9 892,700 2.24.00 7.7 3.9 4.8 5.5 5.9 7.2 8.8 3.7 4.8 5.1 5.0 8.9 7.2 8.8 3.2		29.8		38.5	29.4	36.6	25.3	32.9	20.0
8.6 8.7 8.3 8.7 7.3 7.5 8.6 42.0 49.5 16.1 41.9 41.9 31.8 46.8 45.1 42.0 49.5 16.1 41.9 41.9 31.8 46.8 45.1 42.0 49.5 16.1 41.9 41.9 31.8 46.8 45.1 42.0 49.5 16.1 41.9 41.9 31.8 46.8 45.1 42.0 1.465,700 378,300 1.586,200 70,400 51.2 52.0 5.1 49.3 56.6 21.1 49.6 37.4 51.9 50.6 49.3 56.6 21.1 49.6 37.4 51.9 50.6 49.3 56.6 21.1 49.6 37.4 51.9 50.6 49.3 56.6 21.1 49.6 37.4 51.9 50.6 49.3 56.6 21.1 49.6 37.4 51.9 50.6 49.3 56.6 21.1 49.6 37.4 51.9 46.4 49.3 56.6 22.4 50.0 22.400 1.7 40.1 418,300 324,500 324,500 45.4 49.0 46.4 418,300 324,500 324,500 327,300 324,600 49.6 43.4 43.4 43.5 40.1 21.7 45.6 29.6 43.4 29.9 40.1 21.7 45.6 29.6 43.4 29.9 40.1 21.0 31.0 25.500 1,800 1,100 25.00 8.8 21.0 21.0 21.0 25.600 1,100 25.00 8.8 21.0 21.0 21.0 25.600 1,800 1,100 8.8 21.1 21.7 45.6 29.6 29.3 8.9 21.0 21.0 25.00 1,800 1,100 25.00 8.0 21.0 31.0 25.500 1,800 1,100 25.00 8.0 21.0 31.0 25.500 1,800 1,100 25.00 8.0 21.0 31.0 25.0 21.9 8.1 11.0 11.1 8.1 -1.1 19.1 -1.1 8.1 11.0 11.1 8.1 -1.1 -1.1 8.1 11.0 11.1 8.1 -1.1 -1.1 8.1 11.0 11.1 8.1 -1.1 -1.1 8.1 11.0 11.1 8.1 -1.1 -1.1 8.1 11.0 11.1 8.1 -1.1 -1.1 8.1 11.1 9.1 9.1 9.1 9.1 8.1 11.1 9.1 9.1 9.1 9.1 9.1 8.1 11.1 9.1 9.1 9.1 9.1 9.1 9.1 8.1 11.1 9.1 9.1 9.1 9.1 9.1 9.1 9.1 9.1 8.1 11.1 9.1		9.6		14.8	9.6	0.6	9.4	9.5	8.8
100 64 222 104 15.3 10.9 3.9 46.8 45.1 A2.0 A5.1 Bachelor's degree recipients 41.9 31.6 46.8 45.1 Bachelor's degree recipients 41.9 31.6 46.8 45.1 33.9 1,465,700 378,300 1,585,200 70,400 54,900 127,600 4,77 6.9 5.1 12.3 6.7 7.6 5.5 5.9 6.9 5.1 12.3 6.7 7.7 5.2 6.9 8.3 2.0 8.3 3.1 8.2 3.7 5.1 A3.3 2.0 8.3 3.1 8.2 3.7 5.1 A3.4 5.5 1.2 7.4 3.8 4.8 5.5 A5.2 5.5 1.2 7.4 3.8 4.8 5.5 A5.3 2.0 8.4 34.5 16.7 3.9 4.8 5.5 A5.3 2.0 3.0 37.300 37.300 37.300 37.300 A5.4 3.4 3.4 16.7 23.8 18.6 5.5 A5.5 2.2 2.8 2.4 3.4 2.9 3.0 A5.5 2.2 2.8 2.4 1.4 1.4 1.5 A5.5 2.2 2.8 2.4 1.4 1.4 1.4 A5.6 2.2 2.8 2.4 3.4 2.9 3.0 A5.7 2.1 4.5 2.0 3.3 3.0 A5.8 2.1 4.1 1.4 1.4 1.5 A5.8 2.1 2.1 4.5 2.9 4.4 2.9 3.0 A5.8 2.1 2.1 4.5 2.9 3.0 A5.8 2.1 2.1 4.5 2.9 3.0 A5.9 2.1 3.1 3.1 3.1 3.1 A5.0 2.1 3.1 3.1 3.1 3.1 A5.0 2.1 3.1 4.5 3.1 3.1 3.1 A5.0 2.1 3.1 3.1 3.1 3.1 A5.0 3.1 3.1 3.1 3.1 3.1 3.1 A5.0 3.1 3.1 3.1 3.1 3.1 A5.0 3.1 3.1 3.1 3.1 3.1 3.1 A5.0 3.1 3.1 3		8.6		8.3	8.7	7.3	7.5	8.6	10.0
Marchelor's degree recipients 46.8 45.1		10.0		22.2	10.4	15.3	10.9	3.9	18.8
Bachelor's degree recipients 1,844,000 1,465,700 378,300 1,585,200 70,400 54,900 127,600 4,7 38.2 49.5 5.3 40.6 31.2 38.2 4.5 5.2 40.6 31.2 38.2 4.5 5.2		42.0		16.1	41.9	31.8	46.8	45.1	42.5
1,844,000 1,465,700 378,300 1,585,200 70,400 54,900 127,600 4,7 33.9 29.9 49.5 3.3.5 40.6 31.2 36.2 5.9 6.9 6.4 8.9 7.0 7.6 5.5 5.9 5.9 3.3 2.0 8.3 3.1 8.2 3.7 5.9 5.9 49.3 56.6 2.1.1 49.6 2.0 7.6 5.5 5.0 892,700 660,300 2.22,400 7.2 2.8 3.7 115,100 1,7 892,700 660,300 2.22,400 7.2 8.9 3.8 4.8 5.5 7.2 2.8 12.0 7.7 3.9 4.8 4.6 4.0 1.7 15.2 1.8 4.5 1.6.7 2.3 4.8 5.5 4.6 4.0 4.6 4.0 4.6 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 <td></td> <td></td> <td></td> <td>or's degree recip</td> <td>ients</td> <td></td> <td></td> <td></td> <td></td>				or's degree recip	ients				
33.9 29.9 49.5 33.5 40.6 31.2 36.2 6.6 6.1 12.3 6.7 6.1 7.7 5.2 6.9 6.4 8.3 7.0 7.6 5.5 5.9 3.3 2.0 8.3 7.0 7.6 5.5 5.0 Master's degree recipients 892,700 660,300 232,400 725,600 24,000 115,100 1,7 892,700 660,300 232,400 725,600 25,800 24,00 115,100 1,7 7.2 5.5 1.2 33.5 48 5.5 1,7 38 8.4 8.5 1,8 1,5 1,4 1,5 1,4 1,5 1,4 1,4 1,5 1,4	All S&E occupations (total number)	1,844,000	1,465,700	378,300	1,585,200	70,400	54,900	127,600	4,700
6.6 6.1 12.3 6.7 6.1 7.7 5.2 6.9 6.9 6.9 6.9 6.4 8.9 7.0 7.0 7.6 5.5 5.9 6.9 6.9 6.4 8.9 7.0 7.0 7.6 5.5 5.9 6.9 6.9 8.3 3.1 8.2 3.7 6.0 6.0 6.0 2.2 4.0 7.2 6.0 0.2 22.4 0.0 7.2 6.0 0.2 22.4 0.0 7.2 6.0 0.2 22.4 0.0 7.2 6.0 0.2 22.4 0.0 7.2 6.0 0.2 22.4 0.0 7.2 6.0 0.2	Computer and math scientists	33.9	29.9	49.5	33.5	40.6	31.2	36.2	22.9
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Life scientists	9.9	5.1	12.3	6.7	6.1	7.7	5.2	6.3
3.3 2.0 8.3 3.1 8.2 3.7 2.0 49.3 566 21.1 49.6 37.4 51.9 50.6 892,700 660,300 222,400 725,600 25,800 24,000 115,100 1,7 30.0 28.8 33.5 28.9 35.7 18.3 38.4 5.5 7.2 7.8 6.9 7.7 3.9 9.3 6.5 5.5 7.5 8.4 34.5 16.7 23.8 18.6 3.3 8.4 5.5 40.1 49.6 13.1 39.3 16.7 49.0 46.4 418,300 324,500 35,800 357,300 9,500 10,200 59,700 1,4 418,300 324,500 38,800 337,300 9,500 10,200 59,700 1,4 45.6 20.3 22.8 22.4 19.8 24.1 18.7 16.7 20.0 5.2 14.2 10.6 14.4	Physical scientists	6.9	6.4	8.9	7.0	7.6	5.5	5.9	10.9
49.3 56.6 21.1 49.6 37.4 51.9 50.6 892,700 660,300 232,400 725,600 25,800 24,000 115,100 1.7 30.0 28.8 33.5 28.9 35.7 18.3 38.4 1.7 7.2 28.8 3.5 16.7 3.9 9.3 48.8 5.5 15.2 8.4 34.5 16.7 3.9 9.3 48.4 15.1 15.2 8.4 34.5 16.7 3.9 4.8 5.5 15.2 8.4 34.5 16.7 2.3 48.8 6.5 5.5 15.2 8.4 34.5 16.7 2.3 48.0 46.4 1.4 40.1 40.1 10.3 12.3 11.8 46.4 46.4 1.4 418,300 324,500 93.00 9,500 10.200 59,700 1.4 18,3 21.4 45.6 24.7 19.8 24.8 <th< td=""><td>Social scientists</td><td>3.3</td><td>2.0</td><td>8.3</td><td>3.1</td><td>8.2</td><td>3.7</td><td>2.0</td><td>6.1</td></th<>	Social scientists	3.3	2.0	8.3	3.1	8.2	3.7	2.0	6.1
Master's degree recipients 892,700 660,300 222,400 725,600 25,800 24,000 115,100 1,7 30.0 28.8 33.5 28.9 35.7 18.3 38.4 1,7 7.2 5.5 12.0 7.4 9.8 4.8 5.5 7.5 7.8 6.9 7.7 3.9 9.3 6.5 7.5 8.4 34.5 16.7 23.8 18.6 3.3 40.1 49.6 13.1 39.3 46.4 46.4 46.4 Ph.D. degree recipients 418,300 324,500 9,800 337,300 9,500 10,200 59,700 1,4 12.9 23.2 28.8 24.7 19.8 24.8 24.1 16.0 24.5 23.2 28.8 24.7 19.8 24.8 24.1 16.0 24.5 23.2 14.2 10.6 16.8 32.1 16.0 27.1 <td< td=""><td>Engineers</td><td>49.3</td><td>9.99</td><td>21.1</td><td>49.6</td><td>37.4</td><td>51.9</td><td>9.09</td><td>53.7</td></td<>	Engineers	49.3	9.99	21.1	49.6	37.4	51.9	9.09	53.7
892,700 660,300 232,400 725,600 25,800 24,000 115,100 1,7 30.0 28.8 3.5 28.9 35.7 18.3 38.4 1,7 7.2 5.5 12.0 7.4 9.8 4.8 5.5 7.5 7.8 6.9 7.7 3.9 9.3 6.5 15.2 8.4 34.5 16.7 23.8 18.6 5.5 40.1 40.6 13.1 39.3 18.6 46.4 46.4 416.30 324,500 93,800 337,300 9,500 10,200 59,700 1,4 418.30 324,500 93,800 337,300 9,500 10,200 59,700 1,4 12.9 13.6 23.2 28.8 24.7 19.8 24.8 24.1 16.0 14.1 16.0 14.1 16.0 16.0 16.0 16.0 16.0 16.0 16.0 16.0 16.0 16.0 16.0 16.0				r's degree recipi	ents				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	All S&E occupations (total number)	892,700		232,400	725,600	25,800	24,000	115,100	1,700
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Computer and math scientists	30.0		33.5	28.9	35.7	18.3	38.4	20.0
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Life scientists	7.2		12.0	7.4	8.6	4.8	5.5	5.5
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Physical scientists	7.5		6.9	7.7	3.9	9.3	6.5	9.6
40.1 49.6 13.1 39.3 49.0 46.4 Ph.D. degree recipients 418,300 324,500 93,800 337,300 9,500 10,200 59,700 1,4 418,300 324,500 93,800 337,300 9,500 10,200 59,700 1,4 418,9 24.5 28.8 24.7 19.8 24.8 24.1 27.1 21.7 45.6 29.6 43.4 29.9 9.0 16.7 20.0 5.2 14.2 10.6 16.8 32.1 30,600 21,600 9,100 25,500 1,800 1,100 2,200 1 8.8 11.2 3.1 8.3 16.7 - 13.0 56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.9 - 0.7 - 0.6 0.6 26.0 16.9 46.8 28.0 25.0 21.9 15.9 <t< td=""><td>Social scientists</td><td>15.2</td><td></td><td>34.5</td><td>16.7</td><td>23.8</td><td>18.6</td><td>3.3</td><td>24.5</td></t<>	Social scientists	15.2		34.5	16.7	23.8	18.6	3.3	24.5
Ph.D. degree recipients 418,300 324,500 93,800 337,300 9,500 10,200 59,700 1,4 12.9 13.6 10.3 12.3 11.8 13.1 16.0 14.0 24.5 23.2 28.8 24.7 19.8 24.8 24.1 18.9 21.7 45.6 29.6 43.4 29.9 9.0 27.1 20.0 5.2 14.2 10.6 16.8 32.1 30,600 21,600 9,100 25,500 1,800 1,100 2,200 1 8.8 11.2 3.1 8.3 16.7 - 13.0 56.7 60.0 9,100 25,500 1,800 1,100 2,200 1 65.7 60.0 49.0 54.9 58.3 58.2 76.2 6.6 0.9 - 0.7 - - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 <	Engineers	40.1		13.1	39.3		49.0	46.4	40.4
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$. degree recipie	ıts				
12.9 13.6 10.3 12.3 11.8 13.1 16.0 24.5 23.2 28.8 24.7 19.8 24.8 24.1 18.9 21.4 10.1 19.1 14.4 15.5 18.7 27.1 21.7 45.6 29.6 43.4 29.9 9.0 16.7 20.0 5.2 14.2 10.6 16.8 32.1 Other professional degree recipients 8.8 11.2 3.1 8.3 16.7 - 13.0 8.8 11.2 3.1 8.3 16.7 - 13.0 56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.9 - 0.7 - - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 - 19.9 8.7	All S&E occupations (total number)	418,300		93,800	337,300	9,500	10,200	59,700	1,400
24.5 23.2 28.8 24.7 19.8 24.8 24.1 18.9 21.4 10.1 19.1 14.4 15.5 18.7 27.1 21.7 45.6 29.6 43.4 29.9 9.0 16.7 20.0 5.2 14.2 10.6 16.8 32.1 Other professional degree recipients 8.8 11.2 3.1 8.3 16.7 - 13.0 8.8 11.2 3.1 8.3 16.7 - 13.0 56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.9 - 0.7 - - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 - - - 0.6	Computer and math scientists	12.9		10.3	12.3	11.8	13.1	16.0	11.8
18.9 21.4 10.1 19.1 14.4 15.5 18.7 27.1 21.7 45.6 29.6 43.4 29.9 9.0 16.7 20.0 5.2 14.2 10.6 16.8 32.1 Other professional degree recipients 30,600 21,600 9,100 25,500 1,800 1,100 2,200 1 8.8 11.2 3.1 8.3 16.7 - 13.0 1 56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.6 0.9 - 0.7 - - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7	Life scientists	24.5		28.8	24.7	19.8	24.8	24.1	16.1
27.1 21.7 45.6 29.6 43.4 29.9 9.0 16.7 20.0 5.2 14.2 10.6 16.8 9.0 Other professional degree recipients 30,600 21,600 9,100 25,500 1,800 1,100 2,200 1 8.8 11.2 3.1 8.3 16.7 - 13.0 13.0 56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.6 0.9 - 0.7 - - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7	Physical scientists	18.9		10.1	19.1	14.4	15.5	18.7	10.8
16.7 20.0 5.2 14.2 10.6 16.8 32.1 Other professional degree recipients 30,600 21,600 9,100 25,500 1,800 1,100 2,200 1 8.8 11.2 3.1 8.3 16.7 - 13.0 13.0 56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.6 0.9 - 0.7 - - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7	Social scientists	27.1		45.6	29.6	43.4	29.9	9.0	50.9
Other professional degree recipients 30,600 21,600 9,100 25,500 1,800 1,100 2,200 1 8.8 11.2 3.1 8.3 16.7 - 13.0 56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.9 - 0.7 - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7	Engineers	16.7		5.2	14.2	10.6	16.8	32.1	10.4
30,600 21,600 9,100 25,500 1,800 1,100 2,200 1 8.8 11.2 3.1 8.3 16.7 - 13.0 56.7 60.0 49.0 54.9 58.2 76.2 0.6 0.9 - 0.7 - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7			-	ssional degree	ecipients				
8.8 11.2 3.1 8.3 16.7 - 13.0 56.7 60.0 49.0 54.9 58.2 76.2 0.6 0.9 - 0.7 - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7	All S&E occupations (total number)	30,600	21,600	9,100	25,500	1,800	1,100	2,200	100
56.7 60.0 49.0 54.9 58.3 58.2 76.2 0.6 0.9 - 0.7 - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7	Computer and math scientists	8.8	11.2	3.1	8.3	16.7	ı	13.0	ı
0.6 0.9 - 0.7 - - 0.6 26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 - 19.9 8.7	Life scientists	299	0.09	49.0	54.9	58.3	58.2	76.2	54.2
26.0 16.9 46.8 28.0 25.0 21.9 1.5 8.1 11.0 1.1 8.1 – 19.9 8.7	Physical scientists	9.0	6.0	ı	0.7	I	I	9.0	I
8.1 11.0 1.1 8.1 – 19.9 8.7	Social scientists	26.0	16.9	46.8	28.0	25.0	21.9	1.5	45.8
	Engineers	8.1	11.0	1.1	8.1	I	19.9	8.7	I

^{- =} weighted value of less than 50

NOTE: Total includes 1,700 persons whose race/ethnicity category was reported as "other."

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates.

Appendix table 3-12. Employed scientists and engineers, by sector of employment, sex, and race/ethnicity: 1995

Sector	Total	Male	Female	White	Black	Hispanic	Asian/Pacific Islander	Native American
			Number					
Total, all sectors	3,185,600	2,472,100	713,500	2,673,700	107,500	90,100	304,600	8,000
Four-year college & university	291,100	210,700	80,400	234,100	000'6	9,300	37,800	006
Other educational institution	275,200	167,000	108,200	228,900	15,400	8,800	21,500	200
Private for-profit	1,970,300	1,614,400	355,900	1,663,000	54,800	51,700	195,900	4,300
Self-employed	113,800	77,500	36,300	106,100	1,200	1,800	4,300	400
Private not-for-profit	91,000	52,900	38,100	76,800	3,600	3,000	7,100	200
Federal Government	252,400	204,900	47,500	210,800	13,700	8,800	17,800	1,100
State & local government	191,700	144,700	47,000	154,000	9,800	6,700	20,100	400
		Perc	Percentage distribution	tion				
Total, all sectors	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Four-year college & university	9.1	8.5	11.3	8.8	8.4	10.3	12.4	11.6
Other educational institution	8.6	8.9	15.2	8.6	14.3	6.7	7.1	8.9
Private for-profit	61.8	65.3	49.9	62.2	51.0	57.4	64.3	53.2
Self-employed	3.6	3.1	5.1	4.0	1.1	2.0	1.4	4.4
Private not-for-profit	2.9	2.1	5.3	2.9	3.4	3.4	2.3	5.7
Federal Government	7.9	8.3	6.7	7.9	12.8	9.6	5.9	13.2
State & local government	0.9	5.9	9.9	5.8	9.1	7.5	9.9	5.1

NOTE: Total includes 1,700 persons whose race/ethnicity category was reported as "other."

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates.

Science & Engineering Indicators – 1998

See figure 3-7.

Appendix table 3-13. Median annual salaries of employed scientists and engineers, by occupation, sex, and race/ethnicity: 1995 (Dollars)

Occupation	Total	Male	Female	White	Black	Hispanic	Asian/Pacific Islander	Native American
All S&E occupations	50,000	52,000	42,000	50,400	45,000	47,000	50,000	48,000
Computer and math scientists	50,000	52,600	45,000 46.100	51,000	44,000	46,500	50.000	42,900 48.000
Mathematicians	53,000	55,000	47,700	53,000	50,000	40,000	54,300	42,300
Postsecondary teachers	41,000	45,000	30,000	40,400	39,000	44,000	43,000	42,900
Life scientists	42,000	45,000	34,600	42,600	35,000	37,000	37,000	40,000
Agricultural scientists	41,000	43,000	33,000	42,000	39,000	33,000	40,000	36,000
Biological scientists	40,000	44,000	34,000	40,000	32,000	35,000	36,000	36,900
Environmental life scientists	40,000	41,000	24,000	40,000	45,000	41,000	24,500	54,100
Postsecondary teachers	49,200	53,000	38,000	50,000	35,000	40,000	43,000	75,000
Physical scientists	47,000	50,000	39,600	48,000	42,000	40,000	45,000	32,000
Chemists, except biochemists	47,000	50,000	38,000	48,000	44,000	45,000	44,600	32,000
Earth scientists	45,000	47,500	40,000	46,000	42,000	38,000	40,000	28,500
Physicists and astronomers	55,800	58,000	50,000	58,000	45,000	22,000	47,000	79,500
Other physical scientists	43,900	45,500	43,000	43,900	30,000	30,000	53,000	29,500
Postsecondary teachers	45,000	49,000	35,000	46,000	37,000	45,000	48,000	46,200
Social scientists	43,000	48,000	37,000	43,300	35,000	40,000	45,000	37,000
Economists	53,500	55,500	20,000	52,000	000'09	67,000	000'09	48,000
Political scientists	33,000	34,500	27,200	33,000	20,000	35,000	28,000	ΑN
Psychologists	40,000	47,000	35,000	40,000	32,000	35,000	32,000	32,000
Sociologists and anthropologists	32,000	38,500	30,000	36,000	32,000	28,500	26,000	12,000
S&T historians and other social scientists	40,000	40,000	42,000	41,500	30,000	32,000	48,000	29,000
Postsecondary teachers	47,000	50,000	40,000	47,800	40,000	42,800	48,000	42,000
Engineers	54,000	55,000	47,000	54,000	48,600	50,000	52,000	53,000
Aerospace engineers	58,000	29,500	49,000	29,000	50,100	20,000	58,000	58,000
Chemical engineers	000'09	60,200	49,700	000'09	000'09	53,000	000'09	41,000
Civil and architectural engineers	50,000	50,000	43,000	50,000	44,000	48,000	51,000	50,000
Electrical and related engineers	26,000	57,000	47,100	57,500	48,000	53,000	52,000	48,000
Industrial engineers	50,000	50,000	45,800	50,000	48,000	45,000	48,000	54,000
Mechanical engineers	52,000	52,500	47,500	52,000	49,000	50,000	52,000	48,000
Other engineers	53,000	54,000	47,000	54,000	48,800	45,000	20,000	50,000
Postsecondary teachers	54,000	55,000	44,300	54,100	53,300	45,000	54,000	000'09

NA = not available; S&T = science and technology

NOTE: Median annual salaries are for full-time employees only.

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates.

See figures 3-8 and 3-9.

Science & Engineering Indicators – 1998

Appendix table 3-14. Median annual salaries of employed scientists and engineers, by sector of employment, sex, and race/ethnicity: 1995

Sector	Total	Male	Female	White	Black	Hispanic	Asian/Pacific Islander	Native American
Total, all sectors	50,000	52,000	42,000	50,400	45,000	47,000	50,000	48,000
Four-year college & university	44,000	48,000	33,600	45,000	40,000	38,500	38,000	46,200
Other educational institution	41,000	44,000	35,500	42,000	34,000	40,000	38,000	37,000
Private for-profit	53,000	55,000	46,000	54,000	47,000	20,000	52,000	48,000
Self-employed	53,500	55,000	50,000	54,000	100,000	32,000	20,000	20,000
Private not-for-profit	41,300	49,000	32,000	42,000	26,000	35,000	46,000	25,200
Federal Government	52,000	53,000	47,000	52,000	50,000	51,000	51,300	20,000
State & local government	44,000	45,000	37,000	44,000	38,000	42,000	46,700	32,000

NOTE: Median annual salaries are for full-time employees only.

SOURCE: National Science Foundation, Science Resources Studies Division, 1995 SESTAT (Scientists and Engineers Statistics Data System) Surveys of Science and Engineering College Graduates.

Appendix table 3-15. Scientists and engineers engaged in R&D, and per 10,000 labor force population, by country: 1979-94

	United States	Japan	Germany ^a	France	United Kingdom	Italy	Canada
	Ciaico				Tangaom	ricity	Odridad
		Total en	gaged in R&D (th	ousands)			
1979	614.5	291.2	116.9	72.9	NA	46.4	NA
1980	651.1	303.2	120.7	74.9	NA	47.0	NA
1981	683.2	311.0	124.7	85.5	127.0	52.1	40.5
1982	711.8	321.0	NA	90.1	128.0	56.7	44.1
1983	751.6	347.4	130.8	92.7	127.0	63.0	45.6
1984	NA	357.4	NA	98.2	129.0	62.0	48.7
1985	801.9	380.3	143.6	102.3	131.0	63.8	52.5
1986	NA	393.0	NA	105.0	134.0	67.8	56.0
1987	877.8	415.6	165.6	109.4	134.0	70.6	58.3
1988	NA	434.6	NA	115.2	137.0	74.8	60.6
1989	924.2	457.5	176.4	120.4	133.0	76.1	62.0
1990	NA	477.9	NA	123.9	133.0	77.9	65.8
1991	960.4	491.1	241.9	129.8	131.0	75.2	65.2
1992	NA	511.4	234.3	141.7	134.0	74.4	73.1
1993	962.7	526.5	229.8	145.9	140.0	74.4	76.6
1994	NA	541.0	NA	149.2	146.0	75.7	NA
		Pe	r 10,000 labor fo	rce			
1979	57.7	51.3	43.4	31.4	NA	20.8	NA
1980	60.0	53.1	44.3	32.1	NA	20.8	NA
1981	61.9	54.5	44.0	36.3	47.5	22.9	33.8
1982	63.6	55.6	NA	37.9	48.0	24.9	36.8
1983	66.4	59.0	45.7	39.1	47.7	27.3	37.4
1984	NA	60.3	NA	41.1	47.3	26.6	39.3
1985	68.4	63.9	49.7	42.8	47.3	27.1	41.7
1986	NA	65.3	NA	43.7	48.2	28.4	43.7
1987	72.2	68.8	56.4	45.4	47.9	29.4	44.6
1988	NA	70.5	NA	47.6	48.5	30.9	45.4
1989	73.6	73.0	59.2	49.6	46.8	31.4	45.6
1990	NA	74.9	NA	49.9	46.7	31.8	46.4
1991	75.7	75.5	61.5	51.8	46.3	30.6	47.1
1992	NA	77.7	59.3	56.4	46.9	30.2	50.2
1993	74.3	79.6	58.0	57.9	49.2	32.6	52.0
1994	NA	81.4	NA	58.8	51.3	33.3	NA

NA = not available

SOURCE: Organisation for Economic Co-operation and Development, Main Statistics database (Paris: 1997).

See figure 3-13.

^aGerman data are for West Germany only before 1989.

Appendix table 3-16. **Total science and engineering jobs: 1996 and projected 2006** (Thousands)

Occupation	1996	2006	Change
TOTAL, ALL OCCUPATIONS	. 132,353	150,927	18,574
ALL S&E OCCUPATIONS	3,060	4,421	1,361
Scientists	. 1,678	2,789	1,111
Life scientists	. 180	221	41
Agricultural and food		29	5
Biological		103	20
Foresters and conservation	. 37	43	6
Medical	. 35	44	9
All other		1	0
Computer, mathematical, and operations research	. 1,028	2,038	1,010
Actuaries		16	0
Computer systems analysts, engineers and scientists		1,937	1,004
Computer engineers and scientists		912	485
Computer engineers		451	235
Database administrators, computer support specialists, other		461	249
Systems analysts		1,025	519
Statisticians		14	0
Mathematicians		17	1
Operations research analysts		54	4
Physical scientists		242	35
Chemists		108	17
Geologists		54	7
Meterologists		8	1
· · · · · · · · · · · · · · · · · · ·		17	-1
Physicists and astronomers		55	12
Social scientists		288	25
		∠60 60	25 9
Economists			_
Psychologists		154	11
Urban and regional planners		31	2
All other		43	2
Engineers	,	1,632	250
Aeronautical and astronautical		57	4
Chemical		57	8
Civil		231	35
Electrical and electronics		472	105
Industrial		131	16
Mechanical		264	36
Metallurgists	_	20	2
Mining		3	0
Nuclear		14	0
Petroleum		11	-2
All other	. 326	373	47

SOURCE: U.S. Bureau of Labor Statistics, Office of Employment Projections, "National Industry-Occupation Employment Projections 1996-2006" (Washington, DC: U.S. Department of Labor, 1997).

See figure 3-15.

Appendix table 4-1.

Gross domestic product and GDP implicit price deflators: 1960-99

	Gross domes (Billions of	•	GDP price ((1992 = 1	
	Calendar year	Fiscal year	Calendar year	Fiscal year
1960	526.6	518.3	0.233	0.233
961	544.8	530.4	0.236	0.237
962	585.2	567.3	0.239	0.239
963	617.4	599.0	0.242	0.242
964	663.0	639.8	0.246	0.245
965	719.1	686.8	0.250	0.249
966	787.8	752.7	0.257	0.255
967	833.6	811.9	0.266	0.263
968	910.6	868.0	0.277	0.273
969	982.2	948.1	0.290	0.285
970	1,035.6	1,009.4	0.306	0.300
971	1,125.4	1,077.4	0.321	0.316
972	1,237.3	1,177.0	0.335	0.331
973	1,382.6	1,306.8	0.354	0.345
974	1,496.9	1,438.1	0.385	0.370
975	1,630.6	1,554.5	0.422	0.408
976	1,819.0	1,730.4	0.446	0.437
977	2,026.9	1,971.4	0.475	0.470
978	2,291.4	2,212.6	0.509	0.503
979	2,557.5	2,495.9	0.553	0.545
980	2,784.2	2,718.9	0.604	0.593
981	3,115.9	3,049.1	0.661	0.652
982	3,242.1	3,211.3	0.702	0.698
983	3,514.5	3,421.9	0.732	0.730
984	3,902.4	3,812.0	0.759	0.758
985	4,180.7	4,102.1	0.786	0.784
986	4,422.2	4,374.3	0.806	0.806
987	4,692.3	4,605.1	0.831	0.829
988	5,049.6	4,953.5	0.861	0.858
989	5,438.7	5,351.8	0.897	0.894
990	5,743.8	5,684.5	0.936	0.932
991	5,916.7	5,858.8	0.973	0.972
992	6,244.4	6,143.2	1.000	1.000
993	6,553.0	6,470.8	1.026	1.026
994	6,935.7	6,830.4	1.050	1.050
995	7,253.8	7,186.9	1.076	1.076
996	7,574.4	7,484.6	1.100	1.101
997	7,957.7	7,859.8	1.129	1.129
998	8,366.5	8,263.5	1.160	1.160
999	8,790.2	8,681.4	1.191	1.191

NOTES: Data are projected for 1997-99 and are from the Mid-Session Review of the 1997 Budget, July 1996, updated for GDP revisions used in the President's 1998 budget.

SOURCES: U.S. Bureau of Economic Analysis, *Survey of Current Business* (Washington, DC: U.S. Department of Commerce, monthly series); and Office of Management and Budget, unpublished tabulations.

Appendix table 4-2. **Purchasing power parity and market exchange rates, by selected country: 1981-96** (Units of foreign currency per U.S. dollar)

			Purchasing po	ower parities			Market exch	ange rates
	Canada	France	Germany	Italy	Japan	United Kingdom	Germany	Japan
1981	1.26	5.62	2.37	878	238	0.519	2.26	221
1982	1.29	5.93	2.32	969	228	0.527	2.43	249
1983	1.30	6.26	2.30	1,073	223	0.534	2.55	238
1984	1.29	6.47	2.26	1,152	221	0.536	2.85	238
1985	1.28	6.62	2.23	1,213	218	0.549	2.94	239
1986	1.28	6.80	2.23	1,276	216	0.553	2.17	169
1987	1.30	6.79	2.20	1,314	210	0.563	1.80	145
1988	1.31	6.74	2.15	1,351	203	0.575	1.76	128
1989	1.32	6.68	2.10	1,376	199	0.590	1.88	138
1990	1.30	6.61	2.09	1,421	195	0.602	1.62	145
1991	1.29	6.53	2.10	1,467	194	0.637	1.66	135
1992	1.27	6.38	2.05	1,450	187	0.612	1.56	127
1993	1.26	6.57	2.10	1,534	184	0.637	1.65	111
1994	1.25	6.64	2.07	1,536	181	0.647	1.62	102
1995	1.23	6.62	2.07	1,589	176	0.670	1.43	94
1996	1.23	6.52	2.20	1,639	177	0.640	NA	NA

NA = not available

SOURCES: Organisation for Economic Co-operation and Development, Main Science and Technology Indicators database (Paris: August 1997); and International Monetary Fund, *International Financial Statistics Yearbook* (Washington, DC: 1996).

Appendix table 4-3.

U.S. R&D expenditures, by performing sector and source of funds: 1970-97 (Millions of current dollars)

Total	GOVT.		III dusti y		FFRDCs		Univers	Universities & colleges	leges			FFRDCs	Othe	Other nonprofit institutions	institutions		FFRDCs
	Federal Govt.	Total	Federal Govt.	Industry ^a	Federal Govt.	Total	Federal I Govt.	Nonfed. govt.	Industry	U&C	Non- profit	Federal Govt. ^b	Total	Federal Govt.	Industry	Non- profit	Federal Govt.
26,235	4,154	17,594	7,306	10,288	473	2,376	1,666	228	63	251	168	732	229	410	92	172	230
26,910	4,409	17,829	7,175	10,654	491	2,533	1,742	259	7	282	180	725	709	427	86	184	215
28,661	4,676	19,004	7,469	11,535	548	2,694	1,843	276	77	308	191	269	771	472	101	198	200
30,905	4,837	20,704	7,600	13,104	545	2,919	1,997	298	87	331	206	829	882	266	105	211	190
33,238	5,133	22,239	7,572	14,667	648	3,119	2,096	314	100	380	229	968	995	639	115	241	210
35,565	5,561	23,460	7,878	15,582	727	3,489	2,344	340	116	424	266	1,027	1,076	675	125	276	225
39,314	5,890	26,107	8,671	17,436	890	3,814	2,566	367	127	463	292	1,206	1,162	711	135	316	245
43,233	6,211	28,863	9,523	19,340	396	4,207	2,809	384	147	541	325	1,467	1,248	740	150	358	275
48,582	6,962	32,222	10,107	22,115	1,082	4,810	3,194	429	176	651	361	1,772	1,402	830	165	407	333
55,269	7,471	37,062	11,354	25,708	1,164	5,540	3,723	477	204	200	377	2,013	1,629	985	180	464	330
63,076	7,831	43,228	12,752	30,476	1,277	6,259	4,216	202	250	877	411	2,306	1,700	1,000	200	200	475
72,190	8,605	50,425	14,997	35,428	1,385	996'9	4,620	564	303	1,031	449	2,484	1,788	1,038	225	525	538
80,633	9,501	57,166	17,061	40,105	1,484	7,464	4,823	619	320	1,159	512	2,544	1,950	1,175	250	525	525
89,742	10,830	63,683	19,095	44,588	1,585	8,067	5,100	642	411	1,329	282	2,840	2,138	1,313	275	220	009
101,940	11,916	73,061	21,657	51,404	1,739	8,887	5,589	902	496	1,463	633	3,243	2,470	1,550	325	262	625
114,344	13,093	82,376	25,333	57,043	1,863	6,997	6,226	793	292	1,680	704	3,616	2,736	1,700	375	661	663
206	13,504	85,932	26,000	59,932	1,891	11,234	6,870	942	723	1,944	756	3,973	2,835	1,700	425	710	538
125,841	13,588	90,160	28,757	61,403	1,995	12,481	7,556	1,044	811	2,215	855	4,287	2,828	1,569	456	803	501
463	14,342	94,893	28,221	66,672	2,122	13,841	8,392	1,135	903	2,441	696	4,581	3,174	1,762	501	911	510
141,550	15,231	098'66	26,359	73,501	2,195	15,303	9,152	1,248	1,028	2,774	1,101	4,756	3,658	2,062	295	1,035	547
151,655	15,671	107,404	25,802	81,602	2,323	16,610	9,785	1,361	1,147	3,096	1,220	4,894	4,117	2,346	625	1,147	989
160,521	15,249	114,675	24,095	90,580	2,277	17,892	10,447	1,478	1,224	3,412	1,333	5,120	4,611	2,679	089	1,252	969
164,932	15,853	116,757	22,369	94,388	2,353	19,099	11,306	1,508	1,300	3,558	1,428	5,259	4,864	2,806	716	1,342	748
165,188	16,532	115,435	20,844	94,591	1,965	20,221	12,129	1,561	1,376	3,646	1,510	5,289	4,997	2,841	737	1,419	749
168,554	16,440	117,392	20,261	97,131	2,202	21,305	12,826	1,588	1,437	3,867	1,585	5,305	5,152	2,899	764	1,489	759
183,013	17,231	129,830	21,178	108,652	2,273	22,303	13,434	1,670	1,516	4,069	1,613	5,405	5,167	2,822	830	1,516	804
193,206	16,774	139,579	20,931	118,648	2,273	23,134	13,855	1,736	1,613	4,255	1,676	5,405	5,340	2,871	895	1,575	702
205,742	16,450	151,418	20,787	130,631	2,273	24,031	14,285	1,821	1,710	4,457	1,759	5,405	5,520	2,900	296	1,653	644

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Pattems of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

andustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

bincludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximations based on fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal year. For years began on July 1 instead of October 1.

^eDue to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1997 Data Update, <-http://www.nsf.gov/sbe/srs/natpat97/start.htm>>; or NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series)

See figures 4-2, 4-6, and 4-7.

Appendix table 4-4.

U.S. R&D expenditures, by performing sector and source of funds: 1970-97

(Millions of constant 1992 dollars)

Performing sector:	Total U.S.	Federal Govt.		Industry		Industry FFRDCs		Univer	Universities & colleges	solleges			U&C FFRDCs	Othe	er nonpro	Other nonprofit institutions		Nonprofit FFRDCs
Funding sector:	Total U.S.	Federal Govt.	Total	Federal Govt.	Industry ^a	Federal Govt.	F Total	Federal N Govt.	Nonfed. govt.	Industry	U&C	Non- profit	Federal Govt. ^b	Total	Federal Govt.	Industry	Non- profit	Federal Govt.
Calendar year [°]																		
1970	85,842	13,590	57,568	23,906	33,663	1,548	7,775	5,452	746	207	820	220	2,394	2,214	1,340	311	563	753
1971	83,719	13,715	55,468	22,322	33,146	1,528	7,879	5,419	804	221	877	228	2,256	2,204	1,327	305	572	699
1972	85,531	13,953	56,713	22,290	34,424	1,635	8,038	5,499	822	228	920	269	2,295	2,299	1,407	301	591	262
1973	87,361	13,672	58,526	21,483	37,042	1,541	8,250	5,644	843	245	934	583	2,343	2,493	1,600	297	296	537
1974	86,273	13,322	57,723	19,654	38,069	1,682	8,095	5,440	815	258	286	594	2,324	2,581	1,657	298	626	545
1975	84,358	13,191	55,645	18,686	36,959	1,724	8,276	5,560	908	274	1,006	630	2,436	2,552	1,601	296	655	534
1976	88,114	13,202	58,514	19,434	39,079	1,995	8,547	5,750	821	285	1,038	655	2,704	2,604	1,594	303	208	549
1977	91,091	13,087	60,813	20,064	40,748	2,027	8,863	5,919	808	309	1,140	685	3,091	2,630	1,560	316	754	219
1978	95,404	13,672	63,276	19,848	43,428	2,125	9,446	6,272	841	345	1,278	200	3,479	2,753	1,630	324	799	653
1979	100,009	13,519	67,064	20,545	46,519	2,106	10,025	6,737	863	369	1,375	682	3,642	2,948	1,782	326	840	200
1980	104,464	12,969	71,593	21,120	50,474	2,115	10,366	6,983	836	414	1,453	681	3,819	2,816	1,656	331	828	787
1981	109,294	13,027	76,343	22,705	53,637	2,097	10,547	6,995	853	458	1,561	089	3,761	2,706	1,571	341	795	814
1982	114,847	13,533	81,423	24,300	57,122	2,114	10,630	6,870	881	499	1,650	730	3,623	2,777	1,674	326	748	748
1983	122,613	14,796	87,009	26,089	60,920	2,166	11,021	6,967	877	561	1,816	800	3,881	2,920	1,793	376	751	820
1984	134,224	15,689	96,199	28,516	67,683	2,290	11,701	7,359	929	653	1,926	834	4,270	3,252	2,041	428	784	823
1985	145,559	16,667	104,864	32,249	72,615	2,372	12,726	7,926	1,009	757	2,139	896	4,603	3,483	2,164	477	842	843
1986	148,786	16,757	106,629	32,262	74,367	2,346	13,940	8,524	1,169	897	2,412	938	4,930	3,518	2,109	527	882	299
1987	151,499	16,359	108,543	34,620	73,923	2,402	15,025	960'6	1,257	926	2,667	1,029	5,161	3,405	1,889	548	296	604
1988	155,002	16,657	110,207	32,775	77,432	2,464	16,075	9,747	1,318	1,048	2,835	1,125	5,320	3,686	2,047	285	1,058	269
1989	157,761	16,975	111,297	29,378	81,919	2,446	17,056	10,200	1,391	1,146	3,092	1,227	5,300	4,077	2,298	626	1,153	610
1990	161,957	16,736	114,700	27,555	87,145	2,481	17,738	10,450	1,454	1,225	3,307	1,303	5,226	4,397	2,505	299	1,224	629
1991	164,940	15,669	117,832	24,758	93,073		18,385	10,734	1,518	1,257	3,506	1,369	5,261	4,738	2,753	669	1,287	715
1992	164,932	15,853	116,757	22,369	94,388		19,099	11,306	1,508	1,300	3,558	1,428	5,259	4,864	2,806	716	1,342	748
1993	160,977	16,111	112,492	20,313	92,180		19,705	11,820	1,521	1,340	3,553	1,471	5,154	4,870	2,769	718	1,382	730
1994	160,592	15,663	111,847	19,304	92,543	2,098	20,298	12,220	1,513	1,369	3,685	1,510	5,054	4,909	2,762	728	1,419	724
1995	170,142	16,019	120,699	19,689	101,011		20,734	12,489	1,553	1,410	3,783	1,500	5,025	4,804	2,623	772	1,409	747
1996 prelim	175,610	15,246	126,867	19,025	107,842		21,027	12,593	1,578	1,466	3,867	1,523	4,913	4,854	2,609	813	1,431	638
1997 prelim	182,217	14,569	134,105	18,410	115,695		21,283	12,652	1,612	1,515	3,947	1,557	4,787	4,889	2,569	856	1,464	571

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

^aIndustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

Includes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources

levels are approximations based on fiscal year. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1. *Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1997 Data Update, <<http://www.nsf.gov/sbe/srs/natpat97/start.htm>>; or NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

See figures 4-5, 4-6, 5-1, and 5-2.

U.S. R&D expenditures, by source of funds and performer: 1970-97 (Millions of current dollars) Appendix table 4-5.

Funding sector:	Total U.S.			Ш	Federal Gov	Government	1				Industry	itry		U&Cs	_	Nonprofit	_	Nonfed. govt.ª
Performing sector:	Total U.S.	Total	Federal Govt.	Industry	Industry FFRDCs U	U&Cs	U&C FFRDCs ^b	Non- N profit F	Nonprofit FFRDCs	Total	Industry°	U&Cs	Non- profit	U&Cs	Total	Non- profit	U&Cs	U&Csª
Calendar year																		
1970	26,235	14,970	4,154	7,306	473	1,666	732	410	•	10,446	10,288	63	92	251	340	172	168	228
1971	26,910	15,183	4,409	7,175	491	1,742	725	427	-	10,823	10,654	71	86	282	364	184	180	259
1972	28,661	15,976	4,676	7,469		1,843	692	472	•	11,713	11,535	77	101	308	389	198	191	276
1973	30,905	16,563	4,837	7,600	545	1,997	829	266	•	13,296	13,104	87	105	331	417	211	206	298
1974	33,238	17,193	5,133	7,572		2,096	968	639	•	14,882	14,667	100	115	380	470	241	229	314
1975	35,565	18,437	5,561	7,878		2,344	1,027	675		15,823	15,582	116	125	424	542	276	566	340
1976	39,314	20,179	5,890	8,671		2,566	1,206	711		17,698	17,436	127	135	463	809	316	292	367
1977	43,233	21,988	6,211	9,523		2,809	1,467	740		19,637	19,340	147	150	541	683	358	325	384
1978	48,582	24,279	6,962	10,107		3,194	1,772	830		22,456	22,115	176	165	651	292	407	361	429
1979	55,269	27,100	7,471	11,354		3,723	2,013	985		26,092	25,708	204	180	200	841	464	377	477
1980	63,076	29,857	7,831	12,752		4,216		1,000		30,926	30,476	250	200	877	911	200	411	202
1981	72,190	33,666	8,605	14,997		4,620		1,038	538	35,956	35,428	303	225	1,031	974	525	449	564
1982	80,633	37,113	9,501	17,061		4,823		1,175		40,705	40,105	320	250	1,159	1,037	525	512	619
1983	89,742	41,362	10,830	19,095		5,100		1,313		45,274	44,588	411	275	1,329	1,135	220	285	642
1984	101,940	46,319	11,916	21,657	1,739	5,589		1,550	625	52,225	51,404	496	325	1,463	1,228	262	633	902
1985	114,344	52,493	13,093	25,333		6,226		1,700		58,013	57,043	292	375	1,680	1,365	661	704	793
1986	119,907	54,475	13,504	26,000		6,870		1,700		61,079	59,932	723	425	1,944	1,466	710	756	942
1987	125,841	58,254	13,588	28,757	1,995	7,556		1,569		52,669	61,403	811	456	2,215	1,658	803	855	1,044
1988	133,463	59,930	14,342	28,221	Ŋ	8,392	4,581	1,762	510	920,89	66,672	903	501	2,441	1,880	911	696	1,135
1989	141,550	60,301	15,231	26,359	2	9,152		2,062		75,091	73,501	1,028	299	2,774	2,136	1,035	1,101	1,248
1990	151,655	61,456	15,671	25,802		9,785		2,346	836	83,374	81,602	1,147	625	3,096	2,367	1,147	1,220	1,361
1991	160,521	60,563	15,249	24,095	2,277 10	10,447		2,679		92,484	90,580	1,224	089	3,412	2,585	1,252	1,333	1,478
1992	164,932	60,693	15,853	22,369	_	1,306		2,806		96,404	94,388	1,300	716	3,558	2,770	1,342	1,428	1,508
1993	165,188	60,350	16,532	20,844	ĭδ	12,129		2,841		96,704	94,591	1,376	737	3,646	2,928	1,419	1,510	1,561
1994	168,554	60,692	16,440	20,261	2,202 1;	12,826	5,305	2,899		99,332	97,131	1,437	764	3,867	3,074	1,489	1,585	1,588
1995	183,013	63,147	17,231	21,178	ღ	13,434		2,822	•	110,998	108,652	1,516	830	4,069	3,129	1,516	1,613	1,670
1996 prelim	193,206	62,810	16,774	20,931	რ	13,855		2,871	702 12	121,156	118,648	1,613	895	4,255	3,250	1,575	1,676	1,736
1997 prelim	205,742	62,745	16,450	20,787	က	14,285	5,405	2,900	644 13	133,308	130,631	1,710	296	4,457	3,411	1,653	1,759	1,821

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

*Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D performance. For example, nonfederal government support to nonprofits is included in nonprofits' support for their own R&D (data column 16).

bincludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

chdustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

*Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

See text table 4-1 and figures 4-1, 4-2, 4-3, 4-7, 4-8, 5-1, and 5-2.

Appendix table 4-6.

U.S. R&D expenditures, by source of funds and performer: 1970-97

(Millions of constant 1992 dollars)

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997. Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D performance. For example, nonfederal government support to nonprofits is included in nonprofits' support for their own R&D (data column 16).

blocludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

°Industry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

**Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming)

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

See figures 4-1, 4-4, 5-1, and 5-2.

Appendix table 4-7. **U.S. basic research expenditures, by performing sector and source of funds: 1970-97** (Millions of current dollars)

Federal Govt.	Industry Industry FFRDCs Univer	Universities & colleges	sebello		U&C FFRDCs		r nonpro	Other nonprofit institutions	Nonprofit ons FFRDCs
Federal Federal Federal Federal Govt. Total Govt. Industry ^a Govt. ^b	Federal Total Govt.	Nonfed.	Industry U8	Non- U&C profit	Federa Govt.°	_ _ Total	Federal Gov't	Industry	Non- Federal profit Govt.
						!			
563 566 122		173				311	195	44	72
3,698 582 557 101 456 3	3 1,941 1,367	193	48 211	11 123	256	329	207	45	77
603 554 91 463	2,030	195				347	216	47	84
652 595 96 499	2,078	196				371	232	49	06
715 650 114 536	2,217	200				405	245	24	106
760 677 104 573	2,445	212				435	255	09	120
850 750 116 634	2,612	216				477	278	64	135
943 836 135 701	2,883	227				521	301	70	150
1,044 941 156 785	3,255	251				601	351	80	170
1,112 1,054 161 893	3,723	282				693	413	82	195
1,212 1,205 170 1,035	4,176	300				771	461	92	212
1,343 1,477 164 1,313	4,665	329				832	202	105	225
1,522 1,776 253 1,523	4,985	362				881	551	115	212
1,733 2,106 346 1,760	5,411	388				928	613	125	220
1,877 2,472 340 2,132	5,939	424				1,044	929	149	238
1,947 2,731 358 2,373	6,790	487				1,118	681	172	264
2,026 3,930 434 3,496	7,718	588				1,179	200	195	284
2,047 4,181 598 3,583	8,518	650			2,086	1,238	707	210	321
2,116 4,163 656 3,507	9,118	069				1,351	756	230	364
2,309 4,818 986 3,832		750				1,532	860	258	414
2,319 4,629 869 3,760	10,882	821				1,693	947	287	459
2,378 7,376 1,251 6,125	11,831	904			.,	1,850	1,036	313	201
2,419 6,528 712 5,816	12,710	933				1,980	1,114	329	537
2,623 6,427 466 5,961	13,497	957				2,062	1,155	339	267
2,557 6,514 436 6,078	14,267	920				2,075	1,128	351	296
2,638 5,569 190 5,379	14,945	1,017				2,104	1,116	382	909
2,477 6,056 182 5,874	15,500	1,059		_		2,155	1,114	412	630
2,687 6,645 178 6,467									

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

andustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

PFO 1953-63, basic research of industry FRDCs were not separated out from total federal support to the industrial sector for basic research. Thus, the figure for federal support to industry for basic research at nonprofit institutions for those years. The same is true for basic research by nonprofit FRDCs in 1953-87, which is included in federal support for basic research at nonprofit institutions for those years. encludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

*©Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

See figures 4-2 and 4-7.

Appendix table 4-8. **U.S. basic research expenditures, by performing sector and source of funds: 1970-97** (Millions of constant 1992 dollars)

Nonprofit FFRDCs	Federal Govt.	Å Z Z	Å	٩	Š	å Š	g q Z Z	Ž	٩	٩ ۷	° V	° V	° V	° V	° V	° V	° V V	NA _e	28	52	69	29	29	20	71	69	89	74
	Non- profit	236	240	251	254	2/5	203	316	334	353	356	341	306	301	313	337	353	387	423	461	490	515	537	553	268	564	572	585
Other nonprofit institutions	Industry	144	140	140	139	140	4 4 4 4 4 4	147	157	154	157	159	164	171	197	220	242	252	268	288	307	322	329	330	332	355	374	394
r nonprof	Federal Gov't	636	644	645	654	636	600	635	069	746	764	292	282	837	864	867	869	821	878	929	101	1064	1114	1126	1075	1038	1013	1133
Othe	Total	1016	1024	1036	1047	1001	7007	1098	1181	1253	1277	1264	1255	1308	1374	1423	1464	1490	1569	1708	1808	1901	1980	2009	1977	1956	1959	2112
U&C FFRDCs	Federal Govt.°	873	962	292	903	1044	1107	1405	1779	1899	1932	1944	1946	2098	2250	2282	2377	2511	2638	2643	2638	2730	2867	2878	2805	2585	2528	2463
	Non- profit	367	382	400	382	3/8	277	405	413	404	405	397	428	483	501	220	282	641	684	737	286	838	884	905	922	913	929	952
	U&C	621	655	651	615	653	020	673	748	813	864	911	296	1097	1157	1313	1505	1661	1723	1857	1994	2146	2202	2178	2250	2303	2360	2413
segello	Industry	136	149	161	163	164	16.7	177	202	219	246	267	292	339	393	465	260	809	637	889	739	770	802	822	836	828	895	926
Universities & colleges	Nonfed. govt.	565	601	582	555	913	200	478	492	510	497	498	516	530	258	620	730	783	801	836	877	929	933	932	924	945	963	986
Unive	Federal N Govt.	4,284	4,252	4,263	4,159	4,065	4,107	4,341	4,536	4,792	4,904	4,989	4,897	4,943	5,212	5,695	6,197	6,562	6,744	7,030	7,226	7,473	7,886	8,319	8,661	8,875	8,941	8,983
	F Total	5,973	6,039	6,057	5,874	5,755	5,739 5,857	6,075	6,391	6,737	6,915	7,063	7,100	7,392	7,819	8,644	9,577	10,255	0,590	11,148	11,621	12,156	12,710	13,152	13,593	13,894	14,088	14,260
Industry FFRDCs	Federal Govt. ^b	118	103	116	102	127	150 155	158	185	188	199	207	182	160	179	167	145	171	391	444		474	474	479	479	493	485	469
	Industry ^a	1,453	1,419	1,382	1,411	1,391	1,00g	1,477	1,542	1,616	1,714	1,988	2,169	2,405	2,807	3,021	4,338	4,314	4,073	4,271	4,015	6,294	5,816	5,809	5,791	5,001	5,339	5,728
Industry	Federal Govt. Ir	399	314	272	271	536	260	284	306	291	282	248	360	473	448	456	239	720	762	1,099	928	1,285	712	454	415	177	166	158
	Total	1,852	1,733	1,653	1,682	1,687	1,000	1,761	1,848	1,907	1,996	2,236	2,530	2,877	3,255	3,477	4,877	5,033	4,835	5,370	4,943	7,579	6,528	6,263	6,206	5,177	5,505	5,885
Federal Govt.	Federal Govt.	1,841	1,809	1,798	1,843	1,856	1,005 1,005	1,987	2,051	2,013	2,008	2,033	2,167	2,367	2,471	2,479	2,514	2,465	2,458	2,573	2,476	2,444	2,419	2,556	2,436	2,453	2,252	2,379
Total I U.S.	I	11,672	11,503	11,428	11,451	11,520	11,440 11,850	12,484	13,434	13,998	14,327	14,748	15,180	16,203	17,349	18,472	20,952	21,926	22,508	23,937	24,088	27,362	27,044	27,408	27,567	26,628	26,881	27,643
Performing sector:	Funding sector:	Calendar year ^d 1970	1971	1972	1973	19/4	1975	1977	3	1979	1980	1981			:	1985	;	1987			1990	:	1992	1993	1994	1995	į	1997 prelim

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

andustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

PFor 1953-63, basic research of industry FFRDCs were not separated out from total federal support to the industrial sector for basic research. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for basic research by nonprofit FFRDCs in 1953-87, which is included in federal support for basic research at nonprofit institutions for those years.

Includes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximations based on fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the same fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal year. Bot years began on July 1 instead of October 1.

^{*©}Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

Appendix table 4-9.

U.S. basic research expenditures, by source of funds and performer: 1970-97 (Millions of current dollars)

Funding sector:	Total U.S.			ш	Federal Go	Government	+-				Industry	stry		U&Cs		Nonprofit		Nonfed. govt.ª
Performing sector:	Total U.S.	Total	Federal Govt.	Industry	Industry FFRDCs	U&Cs	U&C FFRDCs ^b	Non- P profit	Nonprofit FFRDCs	Total	Industry ^c	U&Cs	Non- profit	U&Cs	Total	Non- profit	U&Cs	U&Csª
Calendar year																		
1970	3,567	2,491	563	122	36	1,309	267	195	» N	530	444	42	44	190	184	72	112	173
1971	3,698	2,545	582	101	33	1,367	256	207	NA®	549	456	48	45	211	200	77	123	193
1972	3,829	2,634	603	91	39	1,429	257	216	NA®	564	463	54	47	218	218	84	134	195
1973	4,051	2,806	652	96	36	1,471	320	232	NA®	909	499	28	49	217	225	06	135	196
1974	4,439	3,091	715	114	49	1,566	402	245	NA®	653	536	63	24	242	252	106	146	200
1975	4,827	3,361	200	104	53	1,732	457	255	NA®	202	573	72	09	265	282	120	165	212
1976	5,291	3,729	820	116	69	1,883	534	278	NA®	771	634	73	64	272	303	135	168	216
1977	5,925	4,181	943	135	75	2,061	299	301	NA®	855	701	84	20	320	342	150	192	227
1978	6,841	4,861	1,044	156	94	2,310	906	351	NA®	968	785	103	80	381	380	170	210	251
1979	7,736	5,487	1,112	161	104	2,648	1,050	413	NA®	1,099	893	121	82	450	418	195	223	282
1980	8,651	6,091	1,212	170	120	2,961	1,167	461	NA®	1,278	1,035	148	92	522	429	215	244	300
1981	9,741	6,728	1,343	164	137	3,296	1,284	202	NA®	1,595	1,313	177	105	602	487	225	262	329
1982	10,658	7,258	1,522	253	128	3,438	1,366	551	NA®	1,843	1,523	202	115	629	515	215	300	362
1983	11,859	7,961	1,733	346	117	3,618	1,536	613	NA®	2,133	1,760	248	125	803	574	220	354	388
1984	13,176	8,676	1,877	340	136	3,958	1,709	929	» N	2,579	2,132	298	149	878	618	238	380	424
1985	14,510	9,384	1,947	358	131	4,474	1,793	681	» N	2,911	2,373	366	172	1,032	969	264	432	487
1986	16,885	10,186	2,026	434	117	4,994	1,915	200	NA	4,142	3,496	451	195	1,213	226	284	472	588
1987	18,213	11,031	2,047	298	142	5,451	2,086	707	NA®	4,297	3,583	202	210	1,380	854	321	532	650
1988	19,381	11,968	2,116	656	337	5,807	2,272	756	24	4,286	3,507	549	230	1,483	953	364	289	069
1989	21,477	13,278	2,309	986	398	6,307	2,371	860	46	4,708	3,832	618	258	1,667	1,075	414	661	750
1990	22,556	13,935	2,319	869	499	6,767	2,470	947	65	4,739	3,760	692	287	1,867	1,194	459	736	821
1991	26,629	15,133	2,378	1,251	461	7,273	2,657	1,036	77	7,187	6,125	749	313	2,089	1,317	501	816	904
1992	27,044	15,538	2,419	712	474	7,886	2,867	1,114	29	6,950	5,816	805	329	2,202	1,421	537	884	933
1993	28,125	16,297	2,623	466	492	8,537	2,953	1,155	72	7,143	5,961	843	339	2,235	1,493	267	925	957
1994	28,934	16,732	2,557	436	503	9,091	2,944	1,128	74	7,307	6,078	878	321	2,361	1,563	296	968	970
1995	28,642	16,876	2,638	190	530	9,547	2,781	1,116	74	6,684	5,379	923	382	2,477	1,588	909	982	1,017
1996 prelim	29,574	16,996	2,477	182	530	9,837	2,781	1,114	74	7,270	5,874	984	412	2,597	1,652	630	1,023	1,059
1997 prelim	31,212	17,680	2,687	178	230	10,142	2,781	1,279	83	7,957	6,467	1,046	445	2,725	1,736	661	1,075	1,113

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

*Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D (data column 16).

pholudes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

^cIndustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

*For 1953-63, basic research of industry FFRDCs were not separated out from total federal support to the industrial sector for basic research. Thus, the figure for federal support to industry or basic research at nonprofit institutions for support for basic research at nonprofit institutions for

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series)

See figures 4-7 and 4-8.

Appendix table 4-10. **U.S. basic research expenditures, by source of funds and performer: 1970-97**(Millions of constant 1992 dollars)

Nonfed. govt.ª	U&Csª	7.67	601	585	555	519	503	483	478	492	510	497	498	516	530	558	620	730	783	801	801	836	877	929	933	932	924	945	963	986
	U&Cs	367	380	400	382	378	391	377	405	413	404	405	397	428	483	201	220	285	641	684	684	737	286	838	884	905	922	913	929	952
Nonprofit	Non- profit	936	240	251	254	275	285	303	316	334	353	326	341	306	301	313	337	353	387	423	423	461	490	515	537	553	268	564	572	282
	Total	603	621	651	637	653	9/9	089	721	747	226	761	738	734	784	814	886	938	1,028	1,107	1,107	1,198	1,275	1,353	1,421	1,455	1,490	1,477	1,502	1,538
U&Cs	U&Cs	621	655	651	615	629	628	611	673	748	813	864	911	296	1,097	1,157	1,313	1,505	1,661	1,723	1,723	1,857	1,994	2,146	2,202	2,178	2,250	2,303	2,360	2,413
	Non- profit	144	4	140	139	140	142	143	147	157	154	157	159	164	171	197	220	242	252	268	268	288	307	322	329	330	335	355	374	394
stry	U&Cs	136	149	161	163	164	170	164	177	202	219	246	267	292	336	393	465	260	809	637	637	889	739	770	802	822	836	828	892	956
Industry	Industry ^c	1 453	1,419	1,382	1,411	1,391	1,359	1,421	1,477	1,542	1,616	1,714	1,988	2,169	2,405	2,807	3,021	4,338	4,314	4,073	4,073	4,271	4,015	6,294	5,816	5,809	5,791	5,001	5,339	5,728
	Total	1 733	1,707	1,683	1,712	1,695	1,672	1,728	1,801	1,900	1,988	2,117	2,414	2,625	2,914	3,396	3,706	5,140	5,174	4,978	4,978	5,247	5,061	7,385	6,950	6,961	6,962	6,214	6,608	7,048
	Vonprofit FFRDCs	ΘVN	NA N	Å	NA®	28	58	25	69	6/	29	20	71	69	89	74														
	Non- profit	989	644	645	654	929	902	622	635	069	746	764	765	785	837	864	867	869	851	878	878	929	1,011	1,064	1,114	1,126	1,075	1,038	1,013	1,133
ŧ	U&C FFRDCs ^b	873	962	797	903	1,044	1,085	1,197	1,405	1,779	1,899	1,932	1,944	1,946	2,098	2,250	2,282	2,377	2,511	2,638	2,638	2,643	2,638	2,730	2,867	2,878	2,805	2,585	2,528	2,463
Government	U&Cs	4 284	4,252	4,263	4,159	4,065	4,107	4,219	4,341	4,536	4,792	4,904	4,989	4,897	4,943	5,212	5,695	6,197	6,562	6,744	6,744	7,030	7,226	7,473	7,886	8,319	8,661	8,875	8,941	8,983
Federal Go	Industry FFRDCs	4	103	116	102	127	126	155	158	185	188	199	207	182	160	179	167	145	171	391	391	444	533	474	474	479	479	493	482	469
Ĕ	Industry	300	314	272	271	296	247	260	284	306	291	282	248	360	473	448	456	539	720	762	762	1,099	928	1,285	712	454	415	177	166	158
	Federal Govt.	1 841	90,5	1,798	1,843	1,856	1,803	1,905	1,987	2,051	2,013	2,008	2,033	2,167	2,367	2,471	2,479	2,514	2,465	2,458	2,458	2,573	2,476	2,444	2,419	2,556	2,436	2,453	2,252	2,379
	Total	8 151	7,919	7,861	7,933	8,024	7,971	8,358	8,810	9,546	9,930	10,087	10,187	10,338	10,878	11,424	11,946	12,639	13,280	13,899	13,899	14,798	14,881	15,549	15,538	15,882	15,942	15,689	15,448	15,659
Total U.S.	Total U.S.	11672	11,503	11,428	11,451	11,520	11,449	11,859	12,484	13,434	13,998	14,327	14,748	15,180	16,203	17,349	18,472	20,952	21,926	22,508	22,508	23,937	24,088	27,362	27,044	27,408	27,567	26,628	26,881	27,643
Funding sector:	Performing sector:	Calendar yeard	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1988	1989	1990	1991	1992	1993	1994	1995	1996 prelim	1997 prelim

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1997.

"Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D (data column 16).

pholudes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources chdustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the subsequent fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

*For 1953-63, basic research of industry FFRDCs were not separated out from total federal support to the industrial sector for basic research. Thus, the figure for federal support for basic research at nonprofit institutions for those years.

Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

See figure 4-7.

Appendix table 4-11.

U.S. applied research expenditures, by performing sector and source of funds: 1970-97 (Millions of current dollars)

Performing sector:	Total U.S.	Federal Govt.		Industry		Industry FFRDCs		Univer	Universities & colleges	solleges			U&C FFRDCs	Othe	r nonpro	Other nonprofit institutions		Nonprofit FFRDCs
Funding sector:	Total U.S.	Federal Govt.	Total	Federal Govt.	Industry ^a	Federal Govt. ^b	Total	Federal N Govt.	Nonfed. govt.	Industry	U&C	Non- profit	Federal Govt.°	Total	Federal Gov't	Industry	Non- profit	Federal Govt.
Calendar year ^d																		
1970	5,742	1,334	3,330	952	2,378	26	439	273	49	17	24	46	215	328	225	33	20	٩ V
1971	5,817	1,355	3,348	206	2,441	29	487	299	28	19	63	48	213	349	241	34	74	٩ V
1972	6,098	1,434	3,407	842	2,562	107	571	355	20	19	78	49	223	357	243	35	79	٩ ۷
1973	6,662	1,527	3,715	883	2,832	110	719	455	82	25	92	29	215	376	257	36	83	٩ ۷
1974	7,312	1,652	4,168	902	3,263	120	292	457	94	30	114	69	184	423	290	40	93	٩ ۷
1975	8,048	1,912	4,431	991	3,440	139	892	532	107	36	133	82	211	463	315	43	105	^α V
1976	8,964	2,068	4,945	1,033	3,912	167	1,029	290	127	44	161	108	249	206	338	48	120	٩ ۷
1977	9,653	2,081	5,424	1,113	4,311	212	1,096	616	131	49	185	116	297	543	322	53	135	٩ ۷
1978	10,695	2,242	6,065	1,195	4,870	235	1,215	099	146	28	222	129	324	614	409	22	150	٩ ۷
1979	12,073	2,415	6,975	1,305	5,670	250	1,363	750	161	89	257	127	360	710	480	09	170	٩ ۷
1980	13,724	2,546	8,175	1,625	6,550	275	1,574	892	168	83	292	137	421	734	489	65	180	٩
1981	16,389	2,731	10,401	2,042	8,329	298	1,750	920	192	103	352	153	422	286	521	75	190	٩
1982	18,261	2,802	11,956	2,593	9,363	367	1,879	983	210	119	393	174	433	825	220	82	190	٩
1983	20,323	2,991	13,513	3,227	10,286	414	2,051	1,088	208	133	431	190	473	880	282	92	200	° V
1984	22,481	2,961	15,218	3,677	11,541	547	2,288	1,208	231	162	479	207	549	918	594	110	214	° V
1985	25,389	3,135	17,625	4,717	12,908	930	2,473	1,280	251	188	532	223	213	947	581	127	238	° V
1986	27,225	3,204	19,131	4,049	15,082	659	2,707	1,362	290	223	299	233	223	1,000	009	144	256	٩
1987	27,819	3,366	19,190	4,037	15,153	623	3,072	1,549	323	251	685	264	532	1,037	593	155	289	° V N
1988	29,466	3,362	20,377	3,846	16,531	371	3,647	1,894	365	290	785	312	547	1,097	299	170	328	99
1989	32,304	3,566	22,317	4,324	17,993	374	4,116	2,102	409	337	806	360	602	1,258	695	191	372	20
1990	34,981	3,652	24,399	2,967	18,432	386	4,369	2,147	443	374	1,008	397	689	1,405	780	212	413	81
1991	38,699	4,094	27,013	5,588	21,425	433	4,544	2,176	470	389	1,085	454	927	1,603	921	231	451	86
1992	37,995	4,337	25,660	4,476	21,184	202	4,810	2,375	471	406	1,111	446	940	1,660	933	243	483	81
1993	37,318	4,838	24,251	4,295	19,956	435	5,068	2,500	495	437	1,157	479	962	1,661	006	251	511	103
1994	36,615	5,006	22,988	3,616	19,372	203	5,272	2,565	202	429	1,235	206	981	1,753	957	260	536	112
1995	40,927	5,054	26,919	3,164	23,755	535	5,532	2,687	536	486	1,305	517	626	1,779	951	282	546	129
1996 prelim	43,353	2,000	29,065	3,125	25,940	535	5,779	2,814	222	515	1,360	535	626	1,883	1,012	304	267	11
1997 prelim	46,208	5,083	31,663	3,102	28,560	535	5,975	2,869	280	545	1,420	260	626	1,863	940	329	292	110

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources:1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

See figures 4-2 and 4-7.

andustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

PFor 1953-63, applied research of industry FFRDCs were not separated out from total federal support to the industrial sector for applied research. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for applied research by nonprofit FFRDCs in 1953-87, which is included in federal support for applied research at industry FFRDCs for those years. The same is true for applied research at industry FFRDCs for those years. institutions for those years.

elncludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

are Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

^{*}Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming), SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

Appendix table 4-12.

U.S. applied research expenditures, by performing sector and source of funds: 1970-97

(Millions of constant 1992 dollars)

Nonprofit s FFRDCs	Non- Federal profit Govt.																														441 87 89 89 89 883 81 81 81 81 81 81 81 81 81 81 81 81 81
Other nonprofit institutions	Industry p		108	108	106	104	102	104	102	108	112	108	109	108	114	121	130	145	162	179	186	198	213	227		238	238 243	243 244 244	243 244 247	243 244 262 262	243 244 262 276
r nonpro	Federal Gov't		736	736	748	724	726	753	747	756	748	803	869	809	789	783	799	782	740	745	714	695	774	832	946)	933	933	933 877 912	933 877 912 884	933 877 912 884 919
Othe	Total		1 073	1,073	1,084	1,064	1,063	1,098	1,098	1,133	1,144	1,205	1,285	1,215	1,190	1,175	1,202	1,209	1,205	1,241	1,248	1,274	1,402	1,500	1,647		1,660	1,660	1,660 1,619 1,670	1,660 1,619 1,670 1,654	1,660 1,619 1,670 1,654
U&C FFRDCs	Federal Govt.°		202	702	662	664	209	478	200	558	626	989	651	269	639	616	647	722	738	687	640	635	671	736	952		940	940 938	940 938 935	940 938 935 911	940 938 935 911 890
	Non- profit	<u>.</u>	150	150	148	145	167	178	200	242	244	253	230	226	232	248	259	273	283	289	318	362	402	424	435		446	446 467	446 467 482	446 467 482 481	446 467 482 481
	U&C		177	177	197	233	267	296	315	360	389	436	465	483	532	260	289	631	677	743	825	912	1,012	1,076	1,115		1,11	1,111	1,111 1,128 1,177	1,111 1,128 1,177 1,214	1,111 1,128 1,177 1,214
solleges	Industry		ሊ	22.0	28	22	69	26	98	86	102	114	123	138	156	169	182	214	240	276	302	337	375	336	400		406	406 425	406 425 437	406 425 437 452	406 425 437 469
Universities & colleges	Nonfed. govt.		161	191	180	209	241	245	253	285	276	287	292	278	291	300	285	304	319	360	386	454	455	473	483		471	471 483	471 483 483	471 483 498	471 483 498 504
Unive	Federal Govt.		807	894	930	1,060	1,287	1,187	1,262	1,322	1,298	1,296	1,357	1,482	1,438	1,400	1,487	1,591	1,629	1,690	1,864	2,200	2,343	2,293	2,236		2,375	2,375 2,436	2,375 2,436 2,444	2,375 2,436 2,444 2,498	2,375 2,436 2,444 2,498 2,557
	Total		1 436	1,436	1,514	1,705	2,032	1,985	2,117	2,307	2,310	2,387	2,467	2,607	2,649	2,676	2,803	3,013	3,148	3,329	3,698	4,236	4,587	4,666	4,669		4,810	4,810 4,939	4,810 4,939 5,023	4,810 4,939 5,023 5,143	4,810 4,939 5,023 5,143 5,253
Industry FFRDCs	Federal Govt. ^b		317	317	508	319	311	311	330	374	447	461	452	455	451	523	266	720	805	780	750	431	417	412	445		202	507 424	507 424 479	507 424 479 497	507 424 479 497 486
	Industry ^a		7 781	7,781	7,594	7,646	8,005	8,469	8,159	8,768	9,083	9,563	10,260	10,848	12,655	13,336	14,054	15,196	16,432	18,714	18,243	19,199	20,054	19,684	22,015		21,184	21,184 19,447	21,184 19,447 18,457	21,184 19,447 18,457 22,084	21,184 19,447 18,457 22,084 23,578
Industry	Federal Govt. I		3 115	3,12	2,822	2,522	2,496	2,349	2,351	2,315	2,345	2,347	2,361	2,691	3,092	3,693	4,409	4,841	6,005	5,024	4,860	4,467	4,819	6,372	5,742	,	4,476	4,476 4,186	4,476 4,186 3,445	4,476 4,186 3,445 2,941	2,44,4 9,41,86 2,9445 1,941
	Total		10 896	10,896	10,416	10,167	10,501	10,818	10,510	11,083	11,428	11,910	12,621	13,539	15,747	17,029	18,463	20,037	22,437	23,739	23,103	23,666	24,873	26,056	27,757		25,660	25,660 23,633	25,660 23,633 21,902	25,660 23,633 21,902 25,026	25,660 23,633 21,902 25,026 26,418
Federal Govt.	Federal Govt.		7 363	4,363	4,214																										
Total U.S.	Total U.S.		18 787	18,787	18,098	18,197	18,831	18,979	19,089	20,091	20,339	21,002	21,847	22,730	24,812	26,010	27,767	29,601	32,320	33,782	33,491	34,222	36,004	37,357	39,765	100	37,885	36,367 36,367	36,367 36,367 34,886	36,367 36,367 34,886 38,049	37,993 36,367 34,886 38,049 39,404
Performing sector:	Funding sector:	-	Calendar year	1970	1971	1972				1976	:	1978	1979		:	:	:	:	:	;	:	:	:		1991	1000	:				

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

Industry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

PFOr 1953-63, applied research of industry FFRDCs were not separated out from total federal support to the industrial sector for applied research. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for applied research by nonprofit FFRDCs in 1953-87, which is included in federal support for applied research at industry FFRDCs for those years. The same is true for applied research at industry FFRDCs for those years. institutions for those years.

elncludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximations based on fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

**Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

See figure 4-7.

Appendix table 4-13. **U.S. applied research expenditures, by source of funds and performer: 1970-97** (Millions of current dollars)

Fockstall Frontiscoperation Frontiscoper	Total U.S.			Ľ	Federal Go	Government	±				Industry	stry		U&Cs		Nonprofit		Nonfed. govt.ª
952 97 273 215 225 NA° 2428 2.378 17 33 54 116 70 46 845 107 365 223 243 NA° 2494 2.441 9 34 55 4 116 70 45 885 110 455 223 243 NA° 2494 2.441 9 34 134 122 74 49 845 110 455 223 243 NA° 2.616 2.562 19 35 78 128 79 49 99 991 139 532 211 315 NA° 3.333 3.263 3 4 114 162 88 110 455 225 211 315 NA° 3.333 3.263 3 4 114 162 88 110 455 225 211 315 NA° 3.519 4 4 8 161 228 120 108 11,195 235 660 324 409 NA° 4.993 4.870 58 56 222 279 150 108 11,195 2.56 86 324 409 NA° 4.993 4.870 58 56 222 279 170 127 122 2.042 2.98 950 422 421 4.89 NA° 4.993 4.870 58 56 222 2.79 170 127 122 2.042 2.98 950 422 421 1.08 8.357 8.359 103 75 350 NA° 4.993 4.870 58 56 292 3.77 180 137 2.227 414 1.088 4.73 550 NA° 9.567 8.369 103 85 393 394 190 153 3.227 414 1.088 4.73 585 NA° 10.514 1.541 162 170 4.79 4.29 1.362 553 600 NA° 10.514 1.541 16.0286 1.362 553 600 NA° 10.514 1.541 16.0286 1.362 553 600 NA° 10.514 1.508 120 1.70 785 640 328 312 312 4.049 66 16.992 1.562 223 144 5.99 66 16.992 1.562 223 144 5.99 66 16.992 1.562 223 144 5.99 66 16.992 1.562 2.34 1.70 8 10 1.30 8 10 1.30 8.32 8.346 3.71 1.894 54.7 599 66 16.992 1.562 2.34 1.70 785 640 3.28 3.45 4.77 6.29 1.362 553 600 NA° 15.49 1.59 1.70 785 640 3.28 3.12 4.77 6.30 1.29 1.30 6.20 1.30 1.30 1.30 1.30 1.30 1.30 1.30 1.3		ш	ederal Govt.	Industry	Industry FFRDCs	U&Cs	U&C FFRDCs ^b	Non- profit	Nonprofit FFRDCs	Total	Industry ^c		Non- profit	U&Cs	Total	Non- profit	U&Cs	U&Csª
952 97 273 215 226 NA* 2,428 2,378 17 33 54 116 70 46 907 107 355 223 243 NA* 2,678 275 36 11 45 11 77 48 883 110 455 2215 227 NA* 2,893 2,852 36 36 142 83 59 905 120 457 184 230 NA* 2,893 2,832 36 46 114 162 39 69 1,103 120 457 184 233 3,440 36 49 114 162 39 49 1,103 167 590 249 333 2,648 3,440 36 49 116 29 49 1,103 167 590 249 3,440 36 40 114 162 39 40 114 4																		
907 67 299 213 241 NA* 2494 2441 19 34 63 122 74 48 88 88 110 455 223 243 NA* 2.893	5,742 3,095		1,334	952	26	273		225		2,428	2,378	17	33	54	116	20	46	49
845 107 355 223 243 NA* 2616 2,562 19 35 78 128 79 49 983 110 455 214 257 NA* 2,612 25 36 40 114 162 93 99 991 129 532 211 315 NA* 4,01 3,440 36 43 135 106 106 93 90 114 162 93 96 114 162 93 106 106 93 96 114 162 93 96 106 93 96 106 106 93 96 106 106 93 96 106 106 106 116 106			1,355	206	29	533		241		2,494	2,441	19	8	63	122	74	48	28
883 110 455 215 257 NA* 2893 2832 25 36 95 142 83 59 991 130 457 184 290 NA* 3,3263 3,263 30 40 114 162 83 59 1,033 167 590 249 338 NA* 4,041 4,917 44 48 161 228 89 1,136 256 660 324 409 NA* 4,983 431 49 161 228 66 16 297 170 18 16 18 16 18 16 18 16 18 16 18 16 18 16 18 18 16 18 16 18 18 16 18 16 18 18 18 18 18 18 18 18 18 18 18 18 18 18 18 18			1,434	845	107	322		243		2,616	2,562	19	32	78	128	62	49	20
905 120 457 184 290 NA* 3,328 3,283 30 40 114 162 98 69 1,033 150 249 338 NA* 4,413 4,411 49 53 186 251 136 108 1,113 212 616 297 356 NA* 4,413 4,311 49 53 186 251 136 108 1,136 235 660 324 409 NA* 4,983 4,870 86 65 222 279 150 129 1,305 256 780 420 88 5,590 88 560 129 170 127 1,305 257 885 NA* 1,541 1,68 53 34 10 174 2,042 257 NA* 1,541 1,68 53 34 10 174 10 2,042 257 1,41 1			1,527	883	110	455		257		2,893	2,832	52	98	92	142	8	29	82
991 139 532 211 315 NA* 3,519 3,440 36 43 133 190 105 86 1,033 167 590 249 338 NA* 4,004 3,912 44 48 161 228 120 108 116 1,195 235 660 324 409 NA* 4,983 4,870 56 55 222 279 150 129 1,025 275 895 421 489 NA* 6,698 6,550 88 6,5 292 279 170 127 1,025 278 350 NA* 10,514 10,286 139 149 53 343 190 105 129 1,025 2,593 367 983 433 550 NA* 10,514 10,286 133 99 431 390 200 190 3,077 1,208 549 549 NA* 10,514 10,286 133 95 431 390 200 190 3,077 1,208 549 581 NA* 10,514 10,286 138 127 144 599 1,362 553 600 NA* 15,49 15,082 223 144 599 264 3,049 629 1,362 553 600 NA* 15,59 16,53 129 170 170 170 170 170 170 170 170 170 170			1,652	902	120	457		290		3,333	3,263	တ္တ	40	114	162	တ္တ	60	95
1,033 167 590 249 338 NA* 4,004 3,912 44 48 161 228 120 108 1,113 212 616 297 355 NA* 4,413 4,311 49 55 186 22 279 170 196 1,955 256 750 360 480 NA* 6,698 6,550 88 65 22 279 170 127 1,625 275 750 360 480 NA* 6,698 6,550 88 65 292 317 180 137 2,042 298 421 489 NA* 6,698 6,550 88 65 292 317 180 170 127 2,042 298 489 NA* 1,614 10,286 393 364 190 187 392 343 190 190 190 187 343 190 190 190			1,912	991	139	532		315		3,519	3,440	36	43	133	190	105	82	107
1,113 212 616 297 355 NA* 4,413 4,311 49 53 185 251 135 116 1,195 235 660 324 409 NA* 4,983 4,870 58 55 222 279 150 129 1,025 275 895 421 489 NA* 6,688 6,5670 68 65 292 279 170 127 2,042 298 950 421 489 NA* 6,688 6,5670 86 292 377 180 137 2,042 298 950 422 8,357 8,359 103 75 352 343 190 157 2,042 298 4,567 9,363 119 6 6 520 343 190 157 2,042 298 499 NA* 1,181 1,154 10,286 139 36 292 344 190 <td></td> <td></td> <td>2,068</td> <td>1,033</td> <td>167</td> <td>290</td> <td></td> <td>338</td> <td></td> <td>4,004</td> <td>3,912</td> <td>4</td> <td>48</td> <td>161</td> <td>228</td> <td>120</td> <td>108</td> <td>127</td>			2,068	1,033	167	290		338		4,004	3,912	4	48	161	228	120	108	127
2,242 1,195 235 660 324 409 NA* 4,983 4,870 58 55 222 279 150 129 2,415 1,305 250 750 360 480 NA* 6,89 6,550 86 65 22 279 170 127 2,734 2,042 286 421 480 NA* 6,89 6,50 86 56 22 279 170 127 2,734 2,042 280 422 521 NA* 6,650 8 66 292 347 170 170 2,802 2,593 367 488 473 550 NA* 1,615 119 86 362 343 190 174 2,991 3,227 471 630 1,780 579 18 1,741 1,628 147 147 147 147 147 147 147 147 147 147 147			2,081	1,113	212	616		355		4,413	4,311	49	23	185	251	135	116	131
2415 1,305 250 750 360 480 NA* 5,798 5,670 68 60 257 297 170 127 2,546 1,625 275 895 421 489 NA* 6,698 6,550 83 65 292 317 180 137 2,702 2,991 3,227 414 1,088 473 585 NA* 10,514 10,286 133 36 431 390 200 190 2,991 3,227 414 1,088 473 585 NA* 10,514 10,286 130 360 190 174 2,991 3,227 414 1,088 473 585 NA* 10,514 10,286 130 200 190 174 2,991 3,627 547 589 NA* 1,514 16 473 489 57 189 489 231 176 489 200 170 889 <td></td> <td></td> <td>2,242</td> <td>1,195</td> <td>235</td> <td>099</td> <td></td> <td>409</td> <td></td> <td>4,983</td> <td>4,870</td> <td>28</td> <td>22</td> <td>222</td> <td>279</td> <td>120</td> <td>129</td> <td>146</td>			2,242	1,195	235	099		409		4,983	4,870	28	22	222	279	120	129	146
1,625 275 895 421 489 NA* 6,550 83 65 292 317 180 137 2,042 298 950 422 521 NA* 9,567 9,363 103 75 352 343 190 153 2,593 367 983 433 550 NA* 1,286 133 364 190 174 3,677 547 1,208 549 584 NA* 1,5184 11,684 16 20 40 10 17 479 422 20 190 190 174 471 630 188 127 532 461 20 190 190 174 471 471 471 471 471 471 471 471 471 471 471 471 471 471 471 472 471 471 471 472 471 471 471 471 471 471 <td< td=""><td></td><td></td><td>2,415</td><td>1,305</td><td>250</td><td>750</td><td></td><td>480</td><td></td><td>5,798</td><td>5,670</td><td>89</td><td>8</td><td>257</td><td>297</td><td>170</td><td>127</td><td>161</td></td<>			2,415	1,305	250	750		480		5,798	5,670	89	8	257	297	170	127	161
2,042 298 950 422 521 NA* 8,537 8,359 103 75 352 343 190 153 2,593 367 983 431 550 NA* 9,667 9,363 119 85 393 364 190 174 3,227 414 1,088 473 550 NA* 10,514 10,286 136 364 190 174 4,717 630 1,280 579 581 NA* 13,224 12,908 188 127 539 461 23 461 23 461 23 461 23 461 23 461 23 461 20 190 170 479 422 214 20 170 48 461 28 234 491 48 23 461 28 234 491 20 190 170 48 48 25 58 20 48 48 25 </td <td></td> <td></td> <td>2,546</td> <td>1,625</td> <td>275</td> <td>895</td> <td></td> <td>489</td> <td></td> <td>6,698</td> <td>6,550</td> <td>83</td> <td>9</td> <td>292</td> <td>317</td> <td>180</td> <td>137</td> <td>168</td>			2,546	1,625	275	895		489		6,698	6,550	83	9	292	317	180	137	168
2,802 2,593 367 983 433 550 NA* 9,567 9,363 119 85 393 364 190 174 2,991 3,227 414 1,088 473 585 NA* 10,514 10,286 133 95 431 390 200 190 2,961 3,677 549 1,208 579 581 NA* 11,541 162 170 479 422 214 207 3,204 4,049 629 1,362 553 600 NA* 15,692 223 144 599 489 256 233 3,366 4,037 623 1,549 532 593 NA* 15,559 15,153 250 170 785 640 328 312 3,366 4,037 623 1,549 537 599 66 16,992 16,531 290 170 785 440 328 312 312			2,731	2,042	298	920		521		8,537	8,359	103	22	352	343	190	153	192
2,991 3,227 414 1,088 473 585 NA* 10,514 10,286 133 95 431 390 200 190 2,961 3,677 547 1,208 549 594 NA* 11,814 162 110 479 422 214 207 3,135 4,717 630 1,280 579 581 NA* 15,489 223 461 529 489 223 3,366 4,037 623 1,549 532 599 NA* 15,559 223 144 599 489 256 233 264 283 386 251 155 685 554 289 264 289 16,531 290 170 785 640 328 312 386 312 489 56 16,992 16,531 290 170 785 640 328 312 380 312 389 348 312 389 374			2,802	2,593	367	983		220		9,567	9,363	119	82	393	364	190	174	210
2,961 3,677 547 1,208 549 594 NA* 11,814 11,541 162 110 479 422 214 207 3,135 4,717 630 1,280 584 NA* 13,224 12,908 188 127 532 461 238 223 3,204 4,049 629 1,362 553 600 NA* 15,559 15,153 223 144 599 489 256 283 284 3,362 3,846 371 1,894 547 599 66 16,992 16,531 290 170 785 640 328 312 3,652 3,846 371 1,894 547 599 66 16,992 16,531 290 170 785 640 328 312 3,652 5,967 374 2,102 602 695 70 18,521 170 786 640 328 312 348		_	2,991	3,227	414	1,088		282		10,514	10,286	133	92	431	330	200	190	208
3,135 4,717 630 1,280 581 NA* 13,224 12,908 188 127 532 461 233 223 3,204 4,049 629 1,362 553 600 NA* 15,489 15,682 223 144 599 489 256 233 3,266 3,846 371 1,894 547 599 66 16,531 290 170 785 640 328 312 3,652 3,846 371 1,894 547 599 66 16,992 16,531 290 170 785 640 328 312 3,652 3,846 371 1,894 547 599 66 16,992 16,531 290 170 786 640 328 312 3,652 5,967 386 2,147 689 76 18,521 17,993 337 191 908 733 372 340 4,034		'	2,961	3,677	547	1,208		594		11,814	11,541	162	110	479	422	214	207	231
3,204 4,049 629 1,362 553 600 NA° 15,449 15,082 223 144 599 489 256 233 3,364 4,037 623 1,549 532 593 NA° 15,559 15,153 251 155 685 554 289 264 3,386 4,037 623 1,549 547 599 66 16,992 16,531 290 170 785 640 328 312 3,556 4,324 371 1,894 547 599 66 16,992 16,531 290 170 785 640 328 312 3,556 4,324 371 2,102 602 695 70 18,521 17,993 337 191 908 733 372 360 3,556 4,324 374 5,588 4,33 2,176 927 921 86 22,045 21,425 389 231 1,085 875 451 424 4,337 4,476 507 2,375 940 933 81 21,834 4,295 4,317 1,117 929 81 21,12 20,091 19,372 459 260 1,235 1,042 536 506 5,054 3,164 535 2,687 979 951 129 24,524 23,755 486 28, 21,305 1,063 546 517 5,000 3,125 535 2,814 979 1,012 111 26,760 5,083 3,102 535 2,869 979 940 110 29,434 28,560 545 3,102 535 2,869 979 940 110 29,434 28,560 545 3,102 535 2,869 979 940 110 29,434 28,560 545 329 1,420 1,155 595 560		CΙ	3,135	4,717	630	1,280		281		13,224	12,908	188	127	532	461	238	223	251
3,366 4,037 623 1,549 532 593 NA* 15,559 15,153 251 155 685 554 289 264 3,362 3,846 371 1,894 547 599 66 16,992 16,531 290 170 785 640 328 312 3,362 3,846 371 1,894 547 599 66 16,992 16,531 290 170 785 640 328 312 3,566 4,324 374 2,102 602 695 70 18,521 17,993 37 191 908 733 372 360 3,656 4,324 374 217 927 86 22,045 21,425 389 231 1,088 810 413 424 4,337 4,476 507 2,375 940 933 81 21,425 389 231 1,117 929 481 437 251	•	ω	3,204	4,049	629	1,362		009		15,449	15,082	223	144	299	489	256	233	290
3,362 3,846 371 1,894 547 599 66 16,392 16,531 290 170 785 640 328 312 3,362 3,846 371 1,894 547 599 66 16,992 16,531 290 170 785 640 328 312 3,566 4,324 374 2,102 602 695 70 18,521 17,993 37 191 908 733 372 360 3,656 4,324 374 2,147 689 780 81 19,148 406 243 1,119 908 451 424 424 444	_	6	3,366	4,037	623	1,549		293		15,559	15,153	251	155	685	554	289	264	323
3,362 3,846 371 1,894 547 599 66 16,392 16,531 290 170 785 640 328 312 332 342	•	4	3,362	3,846	371	1,894		299		16,992	16,531	290	170	785	640	328	312	365
3,566 4,324 374 2,102 602 695 70 18,521 17,993 337 191 908 733 372 360 3,652 5,967 386 2,147 689 780 81 19,018 18,432 374 212 1,008 810 413 397 4,094 5,588 4,33 2,176 927 921 86 22,045 21,184 406 243 1,111 929 483 424 4,838 4,296 456 2,500 962 900 103 20,643 19,956 437 251 1,157 990 511 479 5,006 3,616 962 900 103 20,643 19,956 437 251 1,157 990 511 479 5,004 3,616 535 2,887 951 129 24,524 23,755 486 282 1,305 1,042 546 517 85	•	4	3,362	3,846	371	1,894		299		16,992	16,531	290	170	785	640	328	312	365
3,652 5,967 386 2,147 689 780 81 19,018 18,432 374 212 1,008 810 413 397 397 4,094 5,588 433 2,176 927 921 86 22,045 21,425 389 231 1,085 875 451 424 424 4476 507 2,375 940 933 81 21,834 21,184 406 243 1,117 929 446 466 243 1,1157 990 511 479	•	ო	3,566	4,324	374	2,102		695		18,521	17,993	337	191	806	733	372	360	409
4,094 5,588 433 2,176 927 921 86 22,045 21,425 389 231 1,085 875 451 424	•	N	3,652	2,967	386	2,147		780		19,018	18,432	374	212	1,008	810	413	397	443
4,337 4,476 507 2,375 940 933 81 21,184 406 243 1,111 929 483 446 4,838 4,295 435 2,500 962 900 103 20,643 19,956 437 251 1,157 990 511 479 79 <td< td=""><td>•</td><td>4</td><td>4,094</td><td>5,588</td><td>433</td><td>2,176</td><td></td><td>921</td><td></td><td>22,045</td><td>21,425</td><td>389</td><td>231</td><td>1,085</td><td>875</td><td>451</td><td>424</td><td>470</td></td<>	•	4	4,094	5,588	433	2,176		921		22,045	21,425	389	231	1,085	875	451	424	470
4,838 4,295 435 2,500 962 900 103 20,643 19,956 437 251 1,157 990 511 479 5,006 3,616 503 2,565 981 957 112 20,091 19,372 459 260 1,235 1,042 536 506 5,054 3,164 535 2,687 979 951 129 24,524 23,755 486 282 1,305 1,063 546 517 5,000 3,125 535 2,814 979 1,012 111 26,760 25,940 515 304 1,102 567 535 5,083 3,102 535 2,869 979 940 110 29,434 28,560 545 329 1,420 1,155 595 560	'	0	4,337	4,476	202	2,375		933		21,834	21,184	406	243	1,1	929	483	446	471
5,006 3,616 503 2,565 981 957 112 20,091 19,372 459 260 1,235 1,042 536 506 5,054 3,164 535 2,687 979 951 129 24,524 23,755 486 282 1,305 1,063 546 517 5,000 3,125 535 2,814 979 1,012 111 26,760 25,940 515 304 1,360 1,102 567 535 5,083 3,102 535 2,869 979 940 110 29,434 28,560 545 329 1,420 1,155 595 560		က	4,838	4,295	435	2,500		006		20,643	19,956	437	251	1,157	066	511	479	495
5,054 3,164 535 2,687 979 951 129 24,524 23,755 486 282 1,305 1,063 546 517 5,000 3,125 535 2,814 979 1,012 111 26,760 25,940 515 304 1,360 1,102 567 535 5,083 3,102 535 2,869 979 940 110 29,434 28,560 545 329 1,420 1,155 595 560		_	5,006	3,616	503	2,565		957		20,091	19,372	459	260	1,235	1,042	536	909	202
5,000 3,125 535 2,814 979 1,012 111 26,760 25,940 515 304 1,360 1,102 567 535 5,083 3,102 535 2,869 979 940 110 29,434 28,560 545 329 1,420 1,155 595 560		တ	5,054	3,164	535	2,687		951		24,524	23,755	486	282	1,305	1,063	546	517	536
5,083 3,102 535 2,869 979 940 110 29,434 28,560 545 329 1,420 1,155 595 560		9	5,000	3,125	535	2,814		1,012		56,760	25,940	515	304	1,360	1,102	292	535	222
	46,208 13,61	ω	5,083	3,102	535	2,869		940		29,434	28,560	545	329	1,420	1,155	262	260	280

 $\label{eq:FRDCs} FFRDCs = \text{federally funded research and development centers; } U\&C = \text{universities and colleges}$

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

"Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D (data column 16).

pholudes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

chdustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

See figures 4-7 and 4-8.

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

^{*}For 1953-63, applied research of industry FFRDCs were not separated out from total federal support to the industrial sector for applied research. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for applied research by nonprofit FFRDCs in 1953-87, which is included in federal support for applied research at industry FFRDCs for those years. The same is true for applied research by nonprofit FFRDCs in 1953-87, which is included in federal support for applied research at industry FFRDCs for those years. institutions for those years

^{**}Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

Appendix table 4-14.

U.S. applied research expenditures, by source of funds and performer: 1970-97

(Millions of constant 1992 dollars)

Funding sector:	Total U.S.			<u>ــــــــــــــــــــــــــــــــــــ</u>	Federal Go	Government					Industry	stry		U&Cs		Nonprofit		Nonfed. govt.ª
Performing sector:	Total U.S.	Total	Federal Govt.	Industry	Industry FFRDCs	U&Cs	U&C FFRDCs⁵	Non- I profit	Nonprofit FFRDCs	Total	Industry°	U&Cs	Non- profit	U&Cs	Total	Non- profit	U&Cs	U&Csª
Calendar year	10 707	000	000 7	0 4	2,4	200	7	706	© ≤	7	7 704	u u	00	7.7	220	C	7	1
1970	18,787	0,128	4,303	3,-0	ر ا	400	707	7,40	Ž Ž	7,944	7,781	ပ္ပ	2 2	- 1	ر ا ا	223	200	0 0
	18,098	9,585	4,2,4 4,2,14	2,822	37.0	930	900Z	724 724	Å Å	7,738	7,594	2, 28	8 5	-87 233	381	230	24 24 25	000
	18,831	9,744	4.316	2,352	3.5	1,287	607	726	NA NA	8,176	8,005	6	5	267	402	235	167	241
	18,979	9,366	4,288	2,349	311	1,187	478	753	Š	8,652	8,469	62	14	296	420	241	178	245
	19,089	9,724	4,534	2,351	330	1,262	200	747	NA®	8,347	8,159	88	102	315	449	249	200	253
	20,091	9,961	4,636	2,315	374	1,322	228	756	NA®	8,974	8,768	86	108	360	511	569	242	285
	20,339	9,848	4,384	2,345	447	1,298	626	748	NA®	9,297	9,083	102	112	389	528	284	244	276
	21,002	9,945	4,402	2,347	461	1,296	989	803	NA®	9,786	9,563	114	108	436	547	295	253	287
	21,847	10,061	4,370	2,361	452	1,357	651	869	NA®	10,492	10,260	123	109	465	537	308	230	292
	22,730	10,352	4,217	2,691	455	1,482	269	808	» NA	11,093	10,848	138	108	483	524	298	226	278
	24,812	10,544	4,135	3,092	451	1,438	629	789	NA®	12,925	12,655	156	114	532	520	288	232	291
	26,010	11,006	3,990	3,693	523	1,400	616	783	å N	13,626	13,336	169	121	260	518	271	248	300
	27,767	11,994	4,087	4,409	266	1,487	647	799	» N	14,366	14,054	182	130	289	533	273	259	285
984	29,601	12,555	3,899	4,841	720	1,591	722	782	» N	15,555	15,196	214	145	631	222	282	273	304
985	32,320	13,904	3,991	6,005	802	1,629	738	740	NA®	16,834	16,432	240	162	229	286	303	283	319
986	33,782	12,902	3,976	5,024	780	1,690	289	745	NA®	19,170	18,714	276	179	743	607	317	289	360
	33,491	12,880	4,052	4,860	750	1,864	640	714	Å	18,731	18,243	305	186	825	999	348	318	389
	34,222	12,409	3,905	4,467	431	2,200	635	695	92	19,734	19,199	337	198	912	743	381	362	424
	36,004	13,077	3,975	4,819	417	2,343	671	774	78	20,642	20,054	375	213	1,012	817	415	405	455
	37,357	14,633	3,900	6,372	412	2,293	736	832	87	20,310	19,684	366	227	1,076	865	441	424	473
	39,765	14,616	4,206	5,742	445	2,236	952	946	88	22,652	22,015	400	238	1,115	899	463	435	483
	37,995	13,650	4,337	4,476	202	2,375	940	933	81	21,834	21,184	406	243	1,111	929	483	446	471
	36,367	13,675	4,715	4,186	424	2,436	938	877	100	20,117	19,447	425	244	1,128	965	498	467	483
	34,886	13,091	4,770	3,445	479	2,444	932	912	106	19,142	18,457	437	247	1,177	993	511	482	483
	38,049	12,550	4,698	2,941	497	2,498	911	884	120	22,799	22,084	452	262	1,214	988	202	481	498
996 prelim	39,404	12,339	4,545	2,840	486	2,557	830	919	101	24,323	23,578	469	276	1,236	1,002	515	487	504
997 prelim	40,924	12,061	4,502	2,748	474	2,541	867	832	26	26,069	25,295	483	291	1,258	1,023	527	496	514

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

*Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D (data column 16).

^olncludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

^cIndustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximations based on fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1. For 1953-63, applied research of industry FFRDCs were not separated out from total federal support to the industrial sector for applied research. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for applied research by nonprofit FFRDCs in 1953-87, which is included in federal support for applied research at industry FFRDCs for those years. The same is true for applied research at industry FFRDCs for those years.

**Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). institutions for those years.

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series). See figure 4-7.

Appendix table 4-15. U.S. development expenditures, by performing sector and source of funds: 1970-97 (Millions of current dollars)

Nonprofit FFRDCs	- Federal it Govt.		NA°																									
ions	Non- profit	(n)	33 75	ാന്	4	2	9	7	∞	တ	10	Ξ	12	13	14	15	17	19	21	24	27	30	32	34	32	38	37	39
Other nonprofit institutions	Industry	81	<u>ნ</u> ნ	20	21	22	23	27	90	32	40	42	20	22	92	75	82	91	100	112	125	136	143	147	153	166	179	193
er nonpro	Federal Gov't	220	194	268	314	330	341	328	403	483	525	549	299	715	925	1,100	938	771	407	202	619	722	758	787	814	754	745	682
Oth	Total	268	246	326	377	403	425	459	250	617	670	704	269	006	1,133	1,334	1,193	1,055	726	868	1,019	1,159	1,223	1,275	1,324	1,284	1,302	1,272
U&C FFRDCs	Federal Govt.º	251	257	295 295	309	329	424	203	545	603	719	778	745	832	286	1,244	1,503	1,669	1,761	1,781	1,735	1,537	1,452	1,374	1,380	1,645	1,645	1,645
	Non- profit	9	တေထ	5	15	16	16	17	22	27	30	34	38	42	46	49	21	28	89	79	87	93	86	105	11	114	118	123
	U&C	7	ω τ	4 6	24	27	30	37	48	23	64	27	86	92	105	117	132	150	172	199	221	238	244	254	271	287	298	312
saballoc	Industry	2	ന വ	o O	9	œ	9	4	12	12	18	23	56	58	36	41	49	22	64	74	85	82	83	96	101	107	113	120
Universities & colleges	Nonfed. govt.	9	<u> </u>	17	20	21	24	56	35	34	37	42	46	46	21	22	64	71	80	6	26	103	103	109	111	118	122	127
Unive	Federal Govt.	84	76	82	73	80	93	133	224	325	361	375	402	393	423	472	513	226	691	742	871	866	1,045	1,092	1,171	1,201	1,204	1,274
	Total	112	105	122	137	152	173	227	340	424	210	551	299	902	099	734	808	890	1,076	1,185	1,359	1,518	1,580	1,656	1,765	1,826	1,855	1,956
Industry FFRDCs	Federal Govt. ^b	340	391	399	479	535	654	675	753	810	885	920	686	1,054	1,056	1,102	1,145	1,230	1,414	1,423	1,438	1,383	1,373	1,039	1,196	1,209	1,209	1,209
	Industry ^a	7,466	7,757	9,773	10,868	11,569	12,890	14,328	16,460	19,145	22,891	25,756	29,219	32,542	37,731	41,762	41,354	42,667	46,634	51,676	59,410	63,030	67,388	68,674	71,681	79,518	86,834	95,604
Industry	Federal Govt.	6,232		6,621	~			8,275											23,719			17,256	17,181	16,083	16,209	17,824	17,624	17,507
	Total	13,698	13,924	16,394	17,421	18,352	20,412	22,603	25,216		~			_			62,871					80,286	84,569	84,757	87,890	97,342	04,457	113,111
Federal Govt.	Federal Govt.	2,258	2,473	2,658	2,766		2,972										8,275			9,355			<u>~</u>	_		9,539	9,297	_
Total U.S.	Total U.S.	16,926	17,395 18 73/	20,193	21,488	22,691	25,059	27,655	31,047	35,460	40,701	46,060	51,714	57,560	66,284	74,444	75,796	79,809	84,614	87,767	94,118	95,193	99,894	99,746	103,005	13,445	20,281	28,323
Performing sector:	Funding sector:	Calendar yeard 1970	1971				:			:									:		:		1992			1995 1	1996 prelim 1	1997 prelim 1

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

^aIndustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

See figures 4-2 and 4-7.

PFOr 1953-63, development expenditures by industry FFRDCs were not separated out from total federal support to the industrial sector for development. Thus, the figure for federal support for development at industry FFRDCs for those years. The same is true for development by nonprofit FFRDCs in 1953-87, which is included in federal support for development at nonprofit institutions for

encludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximations based on fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

^{*©}Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1997 (Arlington, VA: forthcoming).

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

Appendix table 4-16.

U.S. development expenditures, by performing sector and source of funds: 1970-97

(Millions of constant 1992 dollars)

Nonprofit FFRDCs	Federal Govt.	A V	°AN	NA	۹ N	å V	° V V	NA _p	° V	° V	° V	° V	° V	° V	٩ N	٩ N	٩ N	٩ N	° V	488	480	523	547	299	260	546	258	469	400
Suc	Non- profit	86	103	104	107	109	121	137	154	171	179	174	167	171	178	188	202	212	232	254	277	294	309	322	332	341	338	343	351
Other nonprofit institutions	Industry	29	29	25	22	22	25	25	22	29	63	99	89	71	22	98	92	105	110	116	125	133	140	143	144	146	154	163	171
r nonpro	Federal Gov't	720	604	989	756	814	783	764	756	790	873	869	831	853	977	1,218	1,400	1,163	928	473	265	991	742	758	292	775	701	229	604
Othe	Total	877	292	797	920	977	926	953	296	1,020	1,116	1,110	1,065	1,095	1,230	1,492	1,698	1,480	1,270	843	296	1,088	1,191	1,223	1,242	1,261	1,194	1,183	1,126
U&C FFRDCs	Federal Govt.°	820	798	864	833	805	851	949	1,060	1,064	1,092	1,190	1,178	1,061	1,136	1,299	1,583	1,865	2,010	2,046	1,985	1,853	1,579	1,452	1,339	1,315	1,529	1,495	1,457
	Non- profit	33	59	24	33	38	38	36	36	44	48	20	21	24	22	90	62	63	20	79	88	93	96	86	102	106	106	107	109
	U&C	23	25	32	25	9	64	29	28	94	97	106	117	123	129	138	149	163	181	200	222	236	245	244	248	258	266	271	276
sebelloc	Industry	16	4	10	5	9	18	23	30	29	27	30	34	37	40	47	53	61	99	74	82	88	88	89	93	96	66	103	106
Universities & colleges	Nonfed. govt.	21	23	32	47	21	21	23	22	62	61	61	64	99	62	29	20	79	82	93	100	104	106	103	106	106	109	11	113
Univer	Federal N Govt.	274	236	175	199	189	190	209	279	440	288	262	268	573	538	222	601	637	699	802	827	931	1,025	1,045	1,064	1,115	1,117	1,094	1,128
	F Total	366	327	276	344	322	361	388	478	899	821	844	834	853	826	869	932	1,004	1,072	1,249	1,320	1,451	1,560	1,580	1,614	1,681	1,697	1,686	1,732
Industry FFRDCs	Federal Govt. ^b	1.112	1,216	1,200	1,128	1,243	1,269	1,466	1,422	1,479	1,466	1,461	1,438	1,409	1,440	1,390	1,403	1,421	1,481	1,642	1,586	1,536	1,421	1,373	1,013	1,140	1,124	1,099	1,071
	Industry ^a	24.429	24,133	25,396	27,626	28,209	27,441	28,890	30,188	32,323	34,643	37,912	38,994	41,617	44,462	49,680	53,163	51,314	51,366	54,160	57,594	63,446	64,765	67,388	66,923	68,295	73,926	78,925	84,673
Industry	Federal Govt. I	20.391	19,186		18,716			16,859				18,147						26,699	29,040	27,547	23,460	20,254	17,731	17,181	15,673	15,443	16,570	16,018	15,505
	Total	44.820	43,319	44,892	46,342	45,218	43,529	45,749	47,623	49,518	52,535	56,058						78,013			_		82,496		82,596	83,738	90,496	94,944	00,178
Federal Govt.	Federal Govt.	7.387	7,692	7,877	7,512	7,178	_								8,342			10,268									8,868	8,450	7,688 1
Total U.S.	Total U.S.	55,383	54,118	55,906	57,080	55,773	53,820	56,166	58,268	896'09	64,165	67,408	69,734	73,657	78,644	87,276	94,767	94,051	96,081	98,270	97,819	100,512	97,814	99,894	97,203	98,139	105,466	109,326	113,651
Performing sector:	Funding sector:	Calendar year ^d 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 prelim	1997 prelim

FFRDCs = federally funded research and development centers; U&C = universities and colleges

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1997.

andustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

PFOr 1953-63, development expenditures by industry FFRDCs were not separated out from total federal support to the industrial sector for development. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for development by nonprofit FFRDCs in 1953-87, which is included in federal support for development at industry FFRDCs for those years. The same is true for development by nonprofit institutions for

^eIncludes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximations based on fiscal year data. For 1977 and later years, the calendar year approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1.

*©Due to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming).

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

Appendix table 4-17. **U.S. development expenditures, by source of funds and performer: 1970-97** (Millions of current dollars)

Funding sector:	Total U.S.			ш	Federal Go	Government	±				Industry	itry		U&Cs		Nonprofit		Nonfed. govt.ª
Performing sector:	Total U.S.	Total	Federal Govt.	Industry	Industry FFRDCs	U&Cs	U&C FFRDCs ^b	Non- profit	Nonprofit FFRDCs	Total	Industry°	U&Cs	Non- profit	U&Cs	Total	Non- profit	U&Cs	U&Csª
1970	16,926	9,384	2,258	6,232	340	84	251	220		7,489	7,466	2	18	7	40	30	10	9
1971	17,395	9,557	2,473	6,167	391	9/	257	194	Å	7,781	7,757	2	19	∞	42	33	6	7
1972	18,734	10,136	2,640	6,533	402	29	290	213		8,532	8,510	က	19	12	43	32	∞	Ξ
1973	20,193	10,310	2,658	6,621	336	20	295	268		9,798	9,773	2	20	19	20	38	12	17
1974	21,488	10,493	2,766	6,553	479	73	309	314		10,895	10,868	9	21	24	22	45	15	20
1975	22,691	10,977	2,890	6,783	535	80	329	330		11,599	11,569	∞	22	27	29	21	16	21
1976	25,059	12,006	2,972	7,522	654	93	424	341		12,923	12,890	9	23	30	77	61	16	24
1977	27,655	13,133	3,188	8,275	675	133	503	328		14,369	14,328	4	27	37	6	73	17	56
1978	31,047	14,353	3,676	8,756	753	224	542	403		16,505	16,460	15	8	48	109	87	52	32
1979	35,460	16,053	3,944	9,888	810	325	603	483		19,195	19,145	15	32	23	126	66	27	34
1980	40,701	17,516	4,072	10,957	882	361	719	525		22,949	22,891	8	4	64	135	105	8	37
1981	46,060	19,973	4,530	12,791	950	375	778	549		25,824	25,756	33	45	77	144	110	34	42
1982	51,714	22,128	5,178	14,215	686	402	745	299		29,295	29,219	56	20	86	158	120	88	46
1983	57,560	24,622	6,106	15,522	1,054	393	832	715		32,626	32,542	59	22	92	172	130	45	46
1984	66,284	28,108	7,078	17,640	1,056	423	286	925		37,832	37,731	98	92	105	188	143	46	51
1985	74,444	32,187	8,011	20,258	1,102	472	1,244	1,100		41,878	41,762	4	22	117	208	159	49	22
1986	75,796	33,891	8,275	21,517	1,145	513	1,503	938		41,488	41,354	49	82	132	222	171	21	64
1987	79,809	36,524	8,176	24,122	1,230	226	1,669	771		42,813	42,667	22	6	150	251	193	28	71
1988	84,614	37,277	8,864	23,719	1,414	691	1,761	407		46,798	46,634	64	100	172	287	219	99	80
1989	87,767	35,289	9,355	21,049	1,423	742	1,781	202		51,862	51,676	74	112	199	327	248	79	06
1990	94,118	33,820	9,700	18,966	1,438	871	1,735	619		59,617	59,410	85	125	221	362	275	87	26
1991	95,193	31,207	8,778	17,256	1,383	866	1,537	722		53,251	63,030	82	136	238	394	301	93	103
1992	99,894	31,506	9,098	17,181	1,373	1,045	1,452	758		57,620	67,388	88	143	244	450	322	86	103
1993	99,746	30,021	9,071	16,083	1,039	1,092	1,374	787		58,917	68,674	96	147	254	446	340	105	109
1994	103,005	30,219	8,877	16,209	1,196	1,171	1,380	814		71,934	71,681	101	153	271	469	357	11	=======================================
1995	113,445	32,773	9,539	17,824	1,209	1,201	1,645	754		79,791	79,518	107	166	287	477	364	114	118
1996 prelim	120,281	32,239	9,297	17,624	1,209	1,204	1,645	745		87,126	86,834	113	179	298	495	378	118	122
1997 prelim	128,323	31,448	8,681	17,507	1,209	1,274	1,645	682		95,917	95,604	120	193	312	520	397	123	127

FFRDCs = federally funded research and development centers; U&C = universities and colleges

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

*Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D (data column 16).

pholudes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal year. For 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1. chdustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

*For 1953-63, development expenditures by industry FFRDCs were not separated out from total federal support to the industrial sector for applied research. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for applied research by nonprofit FFRDCs in 1953-87, which is included in federal support for applied research at nonprofit institutions for those years.

**Ube to revisions in survey methodology and sampling of industrial R&D, data for 1991 and subsequent years may not be comparable to data for previous years. See NSF/SRS, National Patterns of R&D Resources: 1997 Data Update, <<ht>torthcoming). SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series).

See figure 4-8.

Appendix table 4-18.

U.S. development expenditures, by source of funds and performer: 1970-97

(Millions of constant 1992 dollars)

Funding	Total			Ĺ			4					·		0	•	130	_	Nonfed.
7				_	rederal Go	Governmen	_		ij û û û û û		Industry	stry	200	O&Cs		Nonprom		govt.
sector:	U.S.	Total	Govt.	Industry	FFRDCs	U&Cs	U&C FFRDCs ^b	profit	FFRDCs	Total	Industry ^c	U&Cs	profit	U&Cs	Total	profit	U&Cs	U&Csª
Salendar year⁴																		
, !	55,383	30,704	7,387	20,391	1,112	274	820	720		24,504	24,429	16	29	23	131	86	33	21
	54,118	29,733	7,692	19,186	1,216	236	798	604	NA®	24,206	24,133	14	29	25	131	103	53	23
	55,906	30,248	7,877	19,496	1,200	175	864	636		25,463	25,396	9	22	35	128	104	24	35
	57,080	29,144	7,512	18,716	1,128	199	833	756		27,695	27,626	5	22	25	141	107	ဗ္ဗ	47
	55,773	27,235	7,178	17,009	1,243	189	802	814		28,280	28,209	16	22	61	147	109	88	51
	53,820	26,036	6,854	16,089	1,269	190	851	783		27,511	27,441	8	25	64	129	121	88	51
	56,166	26,908	6,661	16,859	1,466	509	949	764		28,965	28,890	23	25	29	173	137	36	23
	58,268	27,670	6,717	17,435	1,422	279	1,060	220		30,275	30,188	99	22	28	190	154	36	22
	60,968	28,186	7,219	17,195	1,479	440	1,064	290		32,411	32,323	53	29	94	212	171	44	62
	64,165	29,047	7,136	17,892	1,466	288	1,092	873		34,733	34,643	27	හ	26	228	179	48	61
	67,408	29,009	6,745	18,147	1,461	265	1,190	869		38,008	37,912	99	99	106	224	174	20	61
	69,734	30,239	6,859	19,365	1,438	268	1,178	831		39,097	38,994	8	89	117	217	167	21	64
:	73,657	31,517	7,375	20,247	1,409	573	1,061	853		41,726	41,617	37	7	123	225	171	24	99
	78,644	33,641	8,342	21,208	1,440	238	1,136	977		44,577	44,462	40	75	129	235	178	22	62
:	87,276	37,010	9,320	23,226	1,390	222	1,299	1,218		49,813	49,680	47	86	138	248	188	09	29
:	94,767	40,973	10,197	25,788	1,403	601	1,583	1,400		53,311	53,163	23	92	149	264	202	62	20
:	94,051	42,054	10,268	26,699	1,421	637	1,865	1,163		51,480	51,314	61	105	163	275	212	63	62
:	96,081	43,971	9,842	29,040	1,481	699	2,010	928		51,542	51,366	99	110	181	302	232	20	82
	98,270	43,293	10,295	27,547	1,642	805	2,046	473		54,351	54,160	74	116	200	333	254	79	93
:	97,819	39,330	10,427	23,460	1,586	827	1,985	265		57,802	57,594	85	125	222	365	277	88	100
	100,512	36,117	10,359	20,254	1,536	931	1,853	961		63,667	63,446	88	133	236	387	294	93	104
:	97,814	32,066	9,019	17,731	1,421	1,025	1,579	742		64,993	64,765	88	140	245	404	309	96	106
	99,894	31,506	9,098	17,181	1,373	1,045	1,452	758		67,620	67,388	88	143	244	420	322	86	103
	97,203	29,255	8,840	15,673	1,013	1,064	1,339	292		67,160	66,923	93	144	248	434	332	102	106
994	98,139	28,792	8,458	15,443	1,140	1,115	1,315	775		68,536	68,295	96	146	258	446	341	106	106
	105,466	30,468	8,868	16,570	1,124	1,117	1,529	701		74,179	73,926	66	154	566	444	338	106	109
996 prelim	109,326	29,303	8,450	16,018	1,099	1,094	1,495	229		79,191	78,925	103	163	271	450	343	107	11
1997 prelim	113,651	27,852	7,688	15,505	1,071	1,128	1,457	604		84,950	84,673	106	171	276	460	351	109	113

 $\sf FFRDCs=federally funded research and development centers; U\&C=universities and colleges$

NOTES: Data are based on annual reports by performers except for the nonprofit sector; R&D expenditures by nonprofit sector performers have been estimated since 1973 on the basis of a survey conducted in that year. The next updates of these data, covering the years 1953-98, along with technical notes explaining methodological issues of measurement, will be provided in National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1998 (Arlington, VA: forthcoming). Data are preliminary for 1996 and 1997.

Because of limitations in the survey information, data on nonfederal government funding to other performers are not available, and are consequently included in other sectors' support for their own R&D performance. For pholudes R&D expenditures of FFRDCs administered by academic institutions. In 1994, 99 percent of total funds used were from federal sources. example, nonfederal government support to nonprofits is included in nonprofits' support for their own R&D (data column 16).

Pludustry sources of industry R&D expenditures include all nonfederal sources of industry R&D expenditures.

Expenditure levels for academic and Federal Government performers are also in reference to calendar years, which represents a change from previous reporting in National Patterns of R&D Resources. These levels are approximation is equal to 75 percent of the amount reported in the same fiscal year plus 25 percent of the amount reported in the subsequent fiscal years prior to 1977, the respective percentages are 50 and 50, since earlier fiscal years began on July 1 instead of October 1. For 1953-63, development expenditures by industry FFRDCs were not separated out from total federal support to the industrial sector for applied research. Thus, the figure for federal support to industry FFRDCs for those years. The same is true for applied research by nonprofit FFRDCs in 1953-87, which is included in federal support for applied research at

nonprofit institutions for those years.

SOURCE: NSF/SRS, National Patterns of R&D Resources (Arlington, VA: biennial series)

See figure 4-7.

Appendix table 4-19.

Manufacturing and nonmanufacturing R&D expenditures: 1970-95

		All industries			nufacturing ind		All 11011	manufacturing	
	Total	Company	Federal	Total	Company	Federal	Total	Company	Federa
			Millions	s of current	dollars				
1970	18,067	10,288	7,779	17,362	10,063	7,299	705	225	480
1971	18,320	10,654	7,666	17,616	10,402	7,214	704	252	452
1972	19,552	11,535	8,017	18,845	11,258	7,587	707	277	430
973	21,249	13,104	8,145	20,534	12,805	7,729	715	299	416
1974	22,887	14,667	8,220	22,119	14,362	7,757	768	305	463
1975	24,187	15,582	8,605	23,452	15,157	8,295	735	425	310
1976	26,997	17,436	9,561	26,152	16,965	9,187	845	471	374
1977	29,825	19,340	10,485	28,867	18,799	10,068	958	541	417
1978	33,304	22,115	11,189	32,075	21,413	10,662	1,229	702	527
1979	38,226	25,708	12,518	36,686	24,849	11,837	1,540	859	681
	30,220	23,700	12,510	30,000	24,043	11,007	1,540	000	001
1980	44,505	30,476	14,029	42,690	29,439	13,251	1,815	1,037	778
1981	51,810	35,428	16,382	49,904	34,380	15,524	1,906	1,048	858
1982	58,650	40,105	18,545	56,178	38,633	17,545	2,472	1,472	1,000
1983	65,268	44,588	20,680	61,931	42,504	19,427	3,337	2,084	1,253
1984	74,800	51,404	23,396	69,895	48,152	21,743	4,905	3,252	1,653
1985	84,239	57,403	27,196	77,525	52,642	24,883	6,714	4,401	2,313
1986	87,823	59,932	27,891	80,377	55,192	25,185	7,446	4,740	2,706
1987	92,155	61,403	30,752	84,311	56,259	28,052	7,844	5,144	2,700
1988	97,015	66,672	30,343	86,503	59,415	27,088	10,513	7,257	3,256
1989	102,055	73,501	28,554	88,024	63,199	24,826	14,031	10,302	3,729
303		70,501	20,004			24,020	14,001		0,123
1990	109,727	81,602	28,125	88,934	65,251	23,683	20,793	16,351	4,442
1991	116,952	90,580	26,372	88,506	67,639	20,867	28,446	22,941	5,505
1992	119,110	94,388	24,722	90,177	71,025	19,152	28,933	23,363	5,570
1993	117,400	94,591	22,809	86,569	69,901	16,669	30,831	24,690	6,140
1994	119,595	97,131	22,463	90,749	73,375	17,373	28,846	23,756	5,090
1995	132,103	108,652	23,451	100,067	81,236	18,831	32,036	27,415	4,620
	,	,	•	constant 19	-	·	,	•	
1970	59,116	33,663	25,453	56,809	32,927	23,883	2,307	736	1,571
1971	56,995	33,146	23,850	54,805	32,362	22,443	2,190	784	1,406
1972	58,349	34,424	23,925	56,239	33,597	22,642	2,110	827	1,283
1973	60,066	37,042	23,024	58,045	36,197	21,848	2,021	845	1,176
1974	59,405	38,069	21,336	57,412	37,278	20,134	1,993	792	1,202
1975	57,370	36,959	20,410	55,626	35,951	19,675	1,743	1,008	735
1976	60,508	39,079	21,429	58,614	38,024	20,591	1,894	1,056	838
1977	62,840	40,748	22,091	60,821	39,609	21,213	2,018	1,140	879
1978	65,401	43,428	21,972	62,987	42,050	20,937	2,413	1,379	1,035
1979	69,170	46,519	22,651	66,383	44,964	21,419	2,787	1,554	1,232
1980	73,708	50,474	23,235	70,702	48,756	21,946	3,006	1,717	1,289
1981	78,439	53,637	24,802	75,554	52,051	23,503	2,886	1,587	1,299
	83,536	57,122	26,414	80,015	55,026	24,990	3,521	2,097	1,424
1982				,		,	,	,	
1983	89,175	60,920	28,255	84,616	58,073	26,543	4,559 6.459	2,847	1,712
1984	98,488	67,683	30,805	92,030	63,401	28,629	6,458	4,282	2,176
1985	107,236	73,074	34,620	98,689	67,013	31,676	8,547	5,602	2,944
1986	108,975	74,367	34,609	99,736	68,485	31,251	9,239	5,882	3,358
1987	110,945	73,923	37,022	101,501	67,730	33,772	9,443	6,193	3,251
1988	112,672	77,432	35,240	100,463	69,004	31,460	12,210	8,428	3,781
1989	113,743	81,919	31,824	98,105	70,437	27,669	15,638	11,482	4,156
1990	117,181	87,145	30,036	94,975	69,684	25,292	22,205	17,462	4,744
1991	120,171	93,073	27,098	90,942	69,501	21,441	29,229	23,573	5,657
1992	119,110	94,388	24,722	90,177	71,025	19,152	28,933	23,363	5,570
1993	114,407	92,180	22,228	84,362	68,119	16,244	30,045	24,061	5,983
1994	113,946	92,160		86,462				22,634	4,850
	113,540	32,040	21,402	00,402	69,909	16,552	27,483	42,004	4,000

NOTES: As a result of a new sample design, statistics for 1988-91 have been revised. These statistics now better reflect R&D performance among firms in nonmanufacturing industries and small firms in all industries.

SOURCE: National Science Foundation, Science Resources Studies Division, Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming).

^aSee appendix table 4-1 for GDP implicit price deflators used to convert current dollars to constant 1992 dollars.

Appendix table 4-20.

Total expenditures for industrial R&D (financed by company, federal, and other funds), by industry and size of company: 1985-95 (Millions of current dollars)

Industry and size of company	SIC code	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total		84,239	87,823	92,155	97,015	102,055	109,727	116,952	119,110	117,400	119,595	132,103
Manufacturing		77,525	80,377	84,311	86,503	88,024	88,934	88,506	90,177	86,569	90,749	100,067
Food, kindred, and tobacco products	20,21	Ω	Ω	1,206	Ω	Ω	Ω	1,277	1,386	1,345	1,476	1,566
Textiles and apparel	22,23	□	Ω	Ω	□	Ω	Δ	Ω	Ω	Ω	Ω	□
Lumber, wood products, and furniture	24,25	147	144	137	Δ	192	216	۵	Δ	Δ	Ω	□
Paper and allied products	26		Ω	Δ	□	879	1,059	Ω	Ω	Ω	Ω	□
Chemicals and allied products	28	8,540	8,843	9,635	11,067	12,069	13,291	14,648	15,381	Ω	Ω	17,547
Industrial chemicals	281-82,286		3,552	3,716	4,172	4,451	5,010	5,390	5,165	□	Ω	□
Drugs and medicines	283		3,658	Ω	4,906	Ω	□	Ω	7,944	9,146	9,633	10,215
Other chemicals	284-85,287-89		1,633	Ω	1,989	Ω	□	Ω	2,272	Ω	Ω	Δ
Petroleum refining and extraction	13,29	Δ	Ω	1,897	1,997	2,180	2,306	2,498	2,277	2,152	1,950	1,760
Rubber products	30		Ω	Δ	□	Ω	۵	Ω	□	□	Ω	□
Stone, clay, and glass products	32		920	995				Ω		538	591	448
Primary metals	33			730	637	989	739	714	522	699	069	293
Ferrous metals and products	331-32,3398-99		Ω	Δ	253	Ω	۵	□	□	289	Ω	□
Nonferrous metals and products	333-36		458	۵	384	Ω	٥	Ω	Ω	380	Ω	Ω
Fabricated metal products	34	829	895	783	881	904	939	974	1,017	1,158	1,111	1,023
Machinery	35	12,216	Ω	Δ	□	Ω	14,446	14,775	14,938	8,381	8,110	□
Office, computing, and accounting												
machines	357	□	Δ	Δ	Δ	Ω	Δ	Δ	Ω	4,950	4,106	□
Other machinery, except electrical	351-56,358-59		2,396	2,428	2,682	2,729	۵	□	Ω	3,431	4,004	5,041
Electrical equipment	36	14,432	14,980	15,848	14,128	13,318	13,400	13,415	13,360	13,349	15,338	18,751
Radio and TV receiving equipment	365		133	139	149	96	114	Ω	Ω	Ω	Ω	Ω
Communication equipment	366	9,397	699'6	10,184	8,427	7,071	5,928	4,787	Ω	Ω	Ω	Ω
Electronic components	367		Ω	4,286	4,133	4,025	3,914	□	3,567	5,311	6,032	Ω
Other electrical equipment	361-64,369			1,239	1,419	2,126	3,444	□			Ω	
Transportation equipment	37		31,275	34,246	34,775	33,859	31,361	27,428	27,494	27,258	28,087	32,441
Motor vehicles and motor vehicles												
equipment	371	6,984	Δ	Δ	Δ	Ω	Δ	Ω	Ω	11,718	Ω	□
Other transportation equipment	373-75,379	□	Δ	Δ	Δ	□	Δ	Δ	Δ	483	۵	۵
Aircraft and missiles	372,376	22,231	21,050	24,458	24,168	22,331	20,635	16,629	17,158	15,056	14,260	16,951
Professional and scientific instruments	38	5,013	5,103	5,222	5,530	5,992	7,055	8,705	9,542	10,119	11,441	11,976
Scientific and mechanical measuring												
instruments	381-82	□	Δ	Δ	1,959	2,366	3,346	Δ	5,156	5,681	6,952	7,146
Optical, surgical, photographic, and other												
instruments	384-87	□	Δ	Δ	3,571	3,626	3,709	Δ	4,386	4,438	4,489	4,831
Other manufacturing industries	27,31,39	□	382	۵	□	Ω	٥	Ω	Ω	Ω	Ω	Ω
Nonmanufacturing		6,714	7,446	7,844	10,513	14,031	20,793	28,446	28,933	30,831	28,846	32,036

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Appendix table 4-20.

Total expenditures for industrial R&D (financed by company, federal, and other funds), by industry and size of company: 1985-95 (Millions of current dollars)

Industry and size of company	SIC code	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Size												
Fewer than 500 employees		5,866	7,071	7,163	S	7,809	S	13,172	13,557	14,620	13,966	16,662
500 to 999		1,648	1,902	1,725	1,669	1,825	2,154	8,000	7,958	3,230	3,608	4,693
1,000 to 4,999		6,240	7,472	7,262	7,622	7,881	8,411	10,453	11,886	13,334	14,617	16,960
5,000 to 9,999		4,022	4,251	4,501	5,245	5,756	6,746	8,049	8,258	9,135	8,912	9,532
10,000 to 24,999		11,109	10,493	12,043	11,506	10,450	12,486	15,770	15,744	15,421	15,972	17,071
25,000 or more		55,354	56,991	59,461	63,694	68,335	71,030	61,508	61,707	61,659	62,519	67,185

NOTES: As a result of a new sample design, statistics for 1988-91 have been revised since originally published. These statistics now better reflect R&D performance among firms in the nonmanufacturing industries and small firms in all industries. As a result of the new sample design, data for 1991 and later years are not directly comparable with data for 1990 and earlier years. D = data have been withheld to avoid disclosing operations of individual companies; S = imputation of more than 50 percent (for years prior to 1993, data have been withheld); SIC = Standard Industrial Classification

SOURCE: National Science Foundation, Science Resources Studies Division, Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming).

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Appendix table 4-21.

Company and other (except federal) funds for industrial R&D performance, by industry and size of company: 1985-95 (Millions of current dollars)

Industry and size of company	SIC code	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total		57,043	59,932	61,403	66,672	73,501	81,602	90,580	94,388	94,591	97,131	108,652
Manufacturing		52,642	55,192	56,259	59,415	63,199	65,251	62,639	71,025	69,901	73,375	81,236
Food, kindred, and tobacco products	20,21	1,136	1,280	1,204	1,173	1,244	1,248	1,277	1,386	1,345	1,476	1,566
Textiles and apparel	22,23	218	246	243	215	တ	260	236	261	286	316	381
Lumber, wood products, and furniture	24,25	147	144	137	165	192	216	200	234	196	201	229
Paper and allied products	26	929	538	604	752	879	1,059	1,174	1,182	1,191	1,263	1,404
Chemicals and allied products	28	8,310	8,664	9,445	10,828	11,943	13,168	14,439	15,091	16,658	16,559	17,337
Industrial chemicals	281-82,286	3,281	3,374	3,531	3,939	4,340	4,902	5,225	4,911	5,165	4,780	5,139
Drugs and medicines	283	3,481	3,657	4,095	4,900	5,512	5,917	6,947	7,934	9,132	9,625	10,202
Other chemicals	284-85,287-89	1,548	1,633	1,819	1,989	2,091	2,349	2,267	2,246	2,361	2,154	1,996
Petroleum refining and extraction	13,29	2,194	1,971	1,883	1,975	2,162	2,289	2,487	2,268	2,138	1,939	1,754
Rubber products	30	629	655	296	718	867	1,056	۵	1,256	1,059	1,432	1,210
Stone, clay, and glass products	32	825	941	985	269	615	538	455	479	529	553	441
Primary metals	33	730	786	711	620	999	717	902	514	646	672	280
Ferrous metals and products	331-32,3398-99	323	336	249	252	244	231	225	221	272	241	217
Nonferrous metals and products	333-36	407	420	462	368	422	486	481	293	374	431	363
Fabricated metal products	34	780	800	633	718	726	736	748	723	936	898	937
Machinery	35	10,721	10,701	10,577	11,929	13,342	13,575	13,720	13,903	8,295	8,011	9,676
Office, computing, and accounting												
machines	357	8,418	8,380	8,193	9,347	10,725	10,988	10,419	10,614	4,917	4,078	4,699
Other machinery, except electrical	351-56,358-59	2,303	2,321	2,384	2,582	2,618	2,587	3,301	3,289	3,378	3,933	4,976
Electrical equipment	36	9,271	9,767	10,449	9,975	9,575	9,267	8,865	9,516	11,682	13,537	17,060
Radio and TV receiving equipment	365	320	133	139	149	96	114	۵	93	87	64	114
Communication equipment	366	5,174	5,117	5,455	4,798	4,159	3,584	S	3,381	3,954	4,939	3,845
Electronic components	367	2,826	3,357	3,630	3,684	3,655	3,496	3,177	3,320	5,105	5,870	9,628
Other electrical equipment	361-64,369	921	1,160	1,225	1,345	1,664	2,073	Δ	2,722	2,537	2,664	3,473
Transportation equipment	37	12,092	13,567	13,462	13,910	14,596	14,264	14,858	16,292	16,640	17,695	19,311
Motor vehicles and motor vehicles												
equipment	371	6,164	7,171	7,167	7,783	8,756	8,594	9,063	9,132	10,659	11,950	13,590
Other transportation equipment	373-75,379	279	330	326	361	337	283	262	289	297	279	232
Aircraft and missiles	372,376	5,649	990'9	5,939	2,766	5,503	5,387	5,533	6,871	5,684	5,466	5,489
Professional and scientific instruments	38	4,622	4,752	4,950	5,339	5,729	6,318	6,840	7,321	7,542	8,058	8,516
Scientific and mechanical measuring	00 100	4	1	1	1 060	3000	9090	717	0 0 0	904	0 607	707 0
Optical, surgical, photographic, and other	20-102	0,00	1 20,1	5,0	50,	2,500	7,030	5,5	, ,	ć, 2	50,5	0,'0
instruments	384-87	3,026	3,231	3,352	3,476	3,524	3,621	3,823	4,308	4,346	4,371	4,729
Other manufacturing industries	27,31,39	361	380	380	401	438	541	□	299	758	200	835
Nonmanufacturing		4,401	4,740	5,144	7,257	10,302	16,351	22,941	23,363	24,690	23,756	27,415

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Company and other (except federal) funds for industrial R&D performance, by industry and size of company: 1985-95 (Millions of current dollars) Appendix table 4-21.

Industry and size of company	SIC code	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Size												
Fewer than 500 employees		5,127	6,203	6,200	ഗ	S	ഗ	11,285	11,532	13,006	12,802	14,684
500 to 999		1,531	1,765	1,610	1,748	1,934	2,144	7,819	7,807	3,048	3,426	4,468
1,000 to 4,999		5,249	6,243	6,281	6,820	7,546	8,363	9,403	10,865	12,219	13,533	16,162
5,000 to 9,999		3,350	3,455	3,753	4,075	4,509	4,997	7,233	7,495	8,371	8,087	9,289
10,000 to 24,999		8,366	8,489	9,681	10,512	11,631	12,890	12,397	12,328	12,606	13,625	15,125
25,000 or more		33,420	33,777	33,878	36,785	40,703	45,106	42,443	44,361	45,340	45,658	48,924

D = data have been withheld to avoid disclosing operations of individual companies; S = imputation of more than 50 percent (for years prior to 1993, data have been withheld); SIC = Standard Industrial Classification organizations such as research institutions, universities and colleges, nonprofit organizations, other companies, and state governments. Company-financed R&D not performed within the company is excluded. As a result of a new sample design, statistics for 1988-91 have been revised since originally published. These statistics now better reflect R&D performance among firms in the nonmanufacturing industries and small firms in all industries. As a result of the new sample design, data for 1991 and later years are not directly comparable with data for 1990 and earlier years. NOTES: Company funds include funds for industrial R&D work performed within company facilities from all sources except the Federal Government. The funds may be the companies' own or from outside

SOURCE: National Science Foundation, Science Resources Studies Division, Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming).

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See text table 4-3.

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Appendix table 4-22. Federal funds for industrial R&D performance, by industry and size of company: 1985-95 (Millions of current dollars)

Industry and size of company	SIC code	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total		27,196	27,891	30,752	30,343	28,554	28,125	26,372	24,722	22,809	22,463	23,451
Manufacturing		24,883	25,185	28,052	27,088	24,826	23,683	20,867	19,152	16,669	17,373	18.831
Food, kindred, and tobacco products	20,21			8				0	0	0	0	0
Textiles and apparel	22,23	Ω		Ω	Ω	Ω	Ω	S	Δ	Ω	Δ	Δ
Lumber, wood products, and furniture	24,25	0	0	0	Ω	0	0		Ω	Ω	Ω	Δ
Paper and allied products	26	□		Ω	Ω	0	0		Ω	Ω	Ω	Ω
Chemicals and allied products	28	230	179	190	238	126	123	209	S	Ω	Ω	210 S
Industrial chemicals	281-82,286	217	178	185	232	1	109	165	တ	Ω	Ω	۵
Drugs and medicines	283	Ω	-	٥	9	Δ	Ω	□	တ	15	∞	4
Other chemicals 2	284-85,287-89	□	0	۵	0	Ω	Ω	□	တ	Ω	Ω	۵
Petroleum refining and extraction	13,29	Δ	Ω	14	22	တ	တ	Ξ	တ	1	10	9
Rubber products	30		Ω	۵	۵	۵	۵		Ω	Ω	Ω	۵
Stone, clay, and glass products	32	Ω	6	10	۵	۵	۵	Ω	Ω	6	38	9
Primary metals	33	□	Ω	19	17	22	۵	∞	S	23	17	13
Ferrous metals and products331-32,3398-99	31-32,3398-99			Δ	-	Ω	Ω	-	Ω	17	Ω	Δ
Nonferrous metals and products	333-36	0	80	۵	16	Δ	۵	7	Δ	9	Δ	۵
Fabricated metal products	34	49	92	150	163	178	203	226	294	222	243	98
Machinery	35	1,495	Ω	۵	۵	۵	871	1,055	1,035	86	66	۵
Office, computing, and accounting												
machines	357	□	Ω	۵	۵	۵	۵	۵	۵	33	28	۵
	351-56,358-59	Ω	22	44	101	112	۵	Ω	Ω	53	71	64
Electrical equipment	36	5,161	5,213	5,399	4,153	3,743	4,133	4,550	3,844	1,667	1,801	1,690
Radio and TV receiving equipment	365	□	0	0	0	0	0	0	□	Ω	□	Ω
Communication equipment	366	4,223	4,552	4,729	3,630	2,911	2,344		□	Ω		Ω
Electronic components	367	559	Ω	929	449	369	418		247	206	162	Ω
Other electrical equipment	361-64,369	□	Ω	14	74	463	1,371		□	Ω	□	Ω
Transportation equipment	36	۵	17,708	20,784	20,865	19,262	17,097	12,570	11,202	10,617	10,392	13,130
Motor vehicles and motor vehicles												
equipment	371	820	Ω	۵	Δ	Δ	۵	Δ	Δ	Ω	Ω	Ω
Other transportation equipment	373-75,379		Ω	۵	۵	۵	۵		Ω	Ω	Ω	۵
Aircraft and missiles	372-376	16,582	14,984	18,519	18,402	16,828	15,248	11,096	S	9,372	8,794	11,462
Professional and scientific instruments	38	391	351	272	191	263	737	1,865	2,221	2,577	3,384	3,460 S
Scientific and mechanical measuring												
instruments	381-82	Ω	Ω	۵	တ	S	တ	Ω	2,143	2,484	3,266	3,358 S
Optical, surgical, photographic, and												
other instruments	384-87	□	Δ	۵	92	101	87	۵	78	92	118	102
Other manufacturing industries	27,31,39	□	7	۵	۵	۵	۵	□	61	Ω	Ω	۵
Nonmanufacturing industries		2,313	2,706	2,700	3,256	3,729	4,442	5,505	5,570	6,140	2,090	4,620
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Appendix table 4-22. Federal funds for industrial R&D performance, by industry and size of company: 1985-95 (Millions of current dollars)

Industry and size of company	SIC Code 1985	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Size												
Fewer than 500 employees		739	898	963	816	901	895	1,887	2,025	1,614	1,164	1,978
500 to 999		117	137	115	131	117	S	181	151	182	182	225
1,000 to 4,999		991	1,229	981	1,093	958	881	1,050	S	1,115	1,083	798
5,000 to 9,999		672	962	748	864	740	257	816	763	764	825	243
10,000 to 24,999		2,743	2,004	2,362	1,705	1,129	1,526	3,373	3,416	2,816	2,348	1,946 S
25,000 or more		21,934	23,213	25,583	25,734	24,709	24,436	19,065	17,346	16,319	16,862	18,261

D = data have been withheld to avoid disclosing operations of individual companies; S = imputation of more than 50 percent (for years prior to 1993, data have been withheld); SIC = Standard Industrial Classification

NOTE: As a result of a new sample design, statistics for 1988-91 have been revised since originally published. These statistics now better reflect R&D performance among firms in the nonmanufacturing industries and small firms in all industries.

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SOURCE: National Science Foundation, Science Resources Studies Division, Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming).

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Appendix table 4-23. The 100 leading industrial R&D companies, ranked by size of R&D expenditures in 1996 $\,$

1996 rank	1986 rank	Company	R&D expenditures (millions)	R&D/net sales (%)
1	1	General Motors	8,900.0	5.6
2	3	Ford Motor	6,821.0	4.6
3	2	IBM	3,934.0	5.2
4	9	Hewlett-Packard	2,718.0	7.1
5	20	Motorola	2,394.0	8.6
6	4	Lucent Technologies ^a	2,056.0	13.0
7	66	TRW ^a	1,981.0	20.1
8	18	Johnson & Johnson	1,905.0	8.8
9	46	Intel	1,808.0	8.7
10	31	Pfizer	1,684.0	14.9
10	31	FIIZei	1,004.0	14.9
11	12	Chrysler	1,600.0	2.7
12	22	Merck	1,487.3	7.5
13	_	Microsoft	1,432.0	16.5
14	47	American Home Products	1,429.1	10.1
15	5	General Electric	1,421.0	1.8
16	35/63	Bristol Myers Squibb	1,276.0	8.5
17	33	Pharmacia & Upjohn	1,266.0	17.4
18	23	Procter & Gamble	1,221.0	3.5
19	38		· · · · · · · · · · · · · · · · · · ·	10.9
20	36 11	Abbott Laboratories	1,204.8 1,200.0	
20	11	Boeing	1,200.0	5.3
21	26	Lilly	1,189.5	16.2
22	26	Texas Instruments	1,181.0	11.9
23	8	United Technologies	1,122.0	4.8
24	10	Digital Equipment	1,062.3	7.3
25	13	Xerox	1,044.0	6.0
26	6	Dupont	1,032.0	2.7
27	7	Eastman Kodak	1,028.0	6.4
28	16		947.0	6.7
		3M		
29 30	– 21/51	Rhone-Poulenc Lockheed Martin	882.1 784.0	16.3 2.9
00	21/01	Lookilood Martin	701.0	2.0
31	15	Dow Chemical	761.0	3.8
32	17	Monsanto	728.0	7.9
33	53	Schering-Plough	722.8	12.8
34	28	Rockwell International	691.0	6.7
35	_	Sun Microsystems, Inc.	657.1	9.3
36	4	AT&Ta	640.0	1.2
37	75	Apple Computer	604.0	6.1
38	58	Warner-Lambert	554.8	7.7
39	54	ITT Industries	535.2	6.1
40	-	Amgen	528.3	23.6
		-		
41	14	Exxon	520.0	0.4
42	_	Seagate Technology	519.1	6.0
43	78	Philip Morris	515.0	0.9
44	_	Applied Materials	481.4	11.6
45	32	NCR	444.0	6.4
46	- -	Genentech	434.1	51.3
47	61	Caterpillar	410.0	2.5
48	_	Compaq Computer	407.0	2.2
49	60	Advanced Micro Devices	400.7	20.5
50	-	Cisco Systems	399.3	9.7
51	67	Emerson Electric	398.7	3.6
52	37	Goodyear Tire & Rubber	374.5	2.9
53	_	Chiron	371.1	30.7
54	49	Deere	370.3	3.3

Appendix table 4-23. The 100 leading industrial R&D companies, ranked by size of R&D expenditures in 1996

1996 rank	1986 rank	Company	R&D expenditure (millions)	R&D/net sales (%
55	19	McDonnell Douglas	355.0	2.6
56	_	Silicon Graphics	353.5	12.1
57	42	Honeywell	353.3	4.8
58	99	Tandem Computers	345.4	18.2
59	24	AlliedSignal	345.0	2.5
60	25	Unisys	342.9	5.4
61	56	Baxter International	340.0	6.3
62	41	Raytheon	323.3	2.6
63	62	AMP	315.1	5.8
64	- -	Novell	275.6	20.0
65	- 45	Mobil	275.0 275.0	0.4
66	73	Eaton	267.0	3.8
67	29	Northrop Grumman	255.0	3.2
68	_	Bay Networks	253.2	12.3
69	-	Automatic Data Processing	249.6	7.0
70	55	PPG Industries	239.1	3.3
71	-	Cummins Engine	235.0	4.5
72	_	Boston Scientific	212.3	14.5
73	_	Genzyme	211.5	40.8
74	_	DSC Communications	210.1	15.2
75	82	Ingersoll-Rand	209.3	3.1
76	_	General Instrument	209.3	7.8
77	83	Kimberly-Clark	207.9	1.6
78	_	Gillette	204.0	2.1
79	_	LSI Logic	200.5	16.2
80	-	Whirlpool	197.0	2.3
81	_	Case	193.0	3.6
82	_	Micron Technology	191.9	5.3
83	86	Corning	191.3	5.2
84	_	RJR Nabisco	191.0	1.1
85	69	FMC	189.4	3.8
86	74	Rohm & Haas	187.0	4.7
87	84	Textron	185.0	2.0
88	-	Eastman Chemical	184.0	3.8
89	48	Chevron	182.0	0.5
90	-	Tellabs	181.9	20.9
91	_	Analog Devices	177.8	14.9
	_	_		
92	_	Storage Technology	176.4 173.0	8.7 13.6
93	_ 	Lam Research	173.0	13.6
94	44	Shell Oil	173.0	0.6
95 06	-	Sybase	172.0	17.0
96	52	Amoco	171.0	0.5
97	72	Alcoa	165.5	1.3
98	_	Johnson Controls	165.0	1.6
99	-	Dana	164.0	2.1
100	64	NYNEX	163.1	1.2

^{- =} company unranked in 1986; X/X = 1986 ranking of each company before merger

^aLucent Technologies was split off from ATT in 1996. TRW restated its R&D expenses reported to the Securities and Exchange Commission in 1996 to include all "sponsor-supported" R&D, which means that federal R&D funds are now included in the company's total.

SOURCE: Technical Insights, *Inside R&D*, weekly newsletter (Englewood, NJ: John Wiley & Sons, Inc.).

Appendix table 4-24. Concentration of total, federal, company, and other R&D funds and net sales of R&D-performing companies, by size of R&D program: 1985-95

Companies ranked by size of R&D program	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
		Pei	rcent of tot	tal (compa	ny, federa	I, and othe	r) R&D fund	ds			
First 4 (1-4)	18	19	19	18	19	18	16	15	17	15	16
Next 4 (5-8)	12	11	12	12	13	13	8	8	7	8	8
Next 12 (9-20)	17	14	16	17	16	15	12	13	13	14	13
Next 20 (21-40)	13	13	12	12	12	12	11	11	12	13	12
Next 60 (41-100)	16	15	14	15	15	16	15	15	16	15	14
Next 100 (101-200)	9	10	8	8	8	9	12	12	8	9	8
Next 200 (201-400)	5	8	6	7	6	7	6	6	7	7	7
				Percent o	f federal R	&D funds					
First 4 (1-4)	29	30	31	31	36	38	14	11	23	26	35
Next 4 (5-8)	15	16	18	18	15	16	21	18	17	19	19
Next 12 (9-20)	27	28	27	27	30	26	21	27	32	32	27
Next 20 (21-40)	16	15	15	15	11	12	15	13	16	13	8
Next 60 (41-100)	7	7	7	6	6	6	13	11	5	7	5
Next 100 (101-200)	2	2	1	3	1	1	3	4	5	2	3
Next 200 (201-400)	0	1	0	0	0	0	2	2	2	1	3
		Per	cent of cor	npany and	other (ex	cept feder	al) R&D fun	ds			
First 4 (1-4)	23	20	20	21	22	21	17	17	17	16	16
Next 4 (5-8)	7	7	7	7	7	7	7	8	7	7	7
Next 12 (9-20)	12	12	12	12	13	12	10	12	12	12	11
Next 20 (21-40)	12	10	11	12	12	13	10	11	11	11	11
Next 60 (41-100)	18	16	16	16	16	17	16	17	14	14	14
Next 100 (101-200)	10	10	10	10	10	10	15	14	9	9	9
Next 200 (201-400)	7	8	8	8	8	8	7	7	8	8	8
		P	ercent of n	et sales ra	nked by s	ize of total	R&D funds	S			
First 4 (1-4)	8	8	7	7	6	8	7	8	8	8	8
Next 4 (5-8)	4	5	5	5	5	4	3	3	3	2	2
Next 12 (9-20)	5	5	5	5	5	5	4	4	4	5	6
Next 20 (21-40)	8	7	7	6	5	5	4	4	4	5	4
Next 60 (41-100)	12	10	11	11	12	12	12	12	11	10	9
Next 100 (101-200)	13	10	8	9	8	9	9	9	8	8	8
Next 200 (201-400)	15	9	12	10	11	12	11	11	10	10	10

NOTES: Companies were ranked individually for each year; therefore, particular companies comprising the size groups may have changed from year to year. As a result of a new sample design, statistics for 1988-91 have been revised since originally published. These statistics now better reflect R&D performance among firms in the nonmanufacturing industries and small firms in all industries. See the technical notes for more information.

SOURCE: National Science Foundation, Science Resources Studies Division, Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming).

Appendix table 4-25.

Company and other (except federal) R&D funds as a percentage of net sales for industrial R&D performance, by industry and size of company: 1985-95 (Percentages)

Industry and size of company	SIC code	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total		Ą	AN	ΑN	Ą	Ą	AN	Ą	Ą	ΑN	2.7	2.8
Manufacturing		3.0	3.2	3.1	3.1	3.1	3.1	3.2	3.3	3.1	2.9	2.9
	20,21	9.0	9.0	9.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Textiles and apparel	22,23	0.5	0.5	0.4	9.4	0.5	9.0	9.0	9.0	9.0	9.0	6.0
furniture	24,25	0.8	9.0	9.0	9.0	9.0	9.0	6.0	6.0	0.7	9.0	0.7
Paper and allied products	26	0.8	0.7	9.0	8.0	9.0	1.0	Ξ:	1.0	- :	1.0	1.0
Chemicals and allied products	28	4.9	5.1	5.2	5.2	5.4	5.3	5.3	5.4	0.9	5.1	4.7
Industrial chemicals	281-82,286	4.2	4. 4.	4.4	4.2	4.1	4.4	4.4	4.4	4.4	3.3	3.9
Drugs and medicines	283	8.0	8.4	8.7	8.8	8.9	8.8	8.9	9.6	12.5	10.2	10.4
	284-85,287-89	3.1	3.3	3.3	3.4	3.9	3.4	3.0	2.7	2.7	2.5	1.4
	13,29	6.0	1.1	1.0	1.0	6.0	6.0	1.0	6.0	6.0	0.8	0.7
	30	1.8	1.7	1.6	1.7	1.9	2.1	2.3	2.3	2.1	2.3	1.6
ncts	32	2.3	2.4	2.5	2.0	4.8	1.7	1.6	1.6	1.5	1.5	1.5
	33	6.0	1.0	6.0	0.7	0.7	8.0	0.8	9.0	0.7	9.0	0.5
:	331-32,3398-99	0.5	0.7	9.0	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.3
Nonferrous metals and products	333-36	4.	1.5	1.3	1.0	1.0	1.2	1.2	0.7	1.2	6.0	0.7
Fabricated metal products	34	4.	4.	1.2	1.1	1.2	1.	1.2	1.1	1.1	1.0	1.
	35	6.7	7.3	7.1	8.9	7.3	7.2	7.5	7.3	4.5	3.8	3.6
Office, computing, and accounting												
machines	357	12.4	12.4	12.3	11.2	13.1	14.4	14.9	13.7	8.6	6.7	8.1
Other machinery, except electrical	351-56,358-59	5.6	2.9	3.0	2.8	5.6	2.3	2.9	2.9	2.5	2.5	2.4
Electrical equipment	36	4.8	5.1	5.4	5.3	5.2	4.5	4.3	4.0	5.4	5.2	5.4
Radio and TV receiving equipment	365	4.3	3.6	3.2	2.4	1.8	1.6	1.0	9.0	4.0	1.0	1.6
Communication equipment	366	5.4	5.2	5.5	6.1	6.8	6.1	S	7.0	10.1	10.3	8.0
Electronic components	367	8.2	9.2	8.5	8.0	7.7	7.4	7.2	7.0	7.8	7.3	8.0
Other electrical equipment	361-64,369	2.0	2.2	5.6	2.3	2.3	2.2	2.2	2.1	2.3	2.1	2.5
Transportation equipment	37	3.4	3.6	3.4	3.5	3.5	3.4	4.0	4.2	3.9	3.7	3.6
Motor vehicles and motor vehicles												
equipment	371	3.1	3.3	3.4	3.4	3.7	3.7	4.1	4.0	3.7	3.4	3.6
Other transportation equipment	373-75,379	2.3	2.7	2.5	2.6	2.5	2.1	2.1	2.1	1.9	1.2	6.0
Aircraft and missiles	372,376	3.9	4.0	3.6	3.9	3.3	3.1	4.0	4.7	4.7	5.3	4.2
Professional and scientific instruments	38	8.3	8.2	7.5	7.1	6.8	7.1	7.1	7.2	7.2	6.5	7.3
Scientific and mechanical measuring												
instruments	381-82	8.4	8.4	8.1	9.7	6.9	6.9	6.3	6.2	6.4	2.8	9.9
Optical, surgical, photographic, and												
other instruments	384-87	8.1	8.0	7.2	7.1	7.1	7.5	8.0	8.2	7.9	7.2	8.0
Other manufacturing industries	27,31,39	1.0	1.2		1.0	0.9	6.0	0.8	1.3	1.3	1.	1.2
Nonmanufacturing ^a		¥	Ϋ́	Ν Α	ΑĀ	¥	¥	Ϋ́	Ϋ́	ΑN	2.2	2.4
0 3- 1												

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Company and other (except federal) R&D funds as a percentage of net sales for industrial R&D performance, by industry and size of company: 1985–95 (Percentages) Appendix table 4-25.

Industry and size of company	SIC code	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total ^a		Ą	Ą	Ϋ́	Ą	Ą	ΑN	Ϋ́	Ą	Ϋ́	2.7	2.8
Fewer than 500 employees		3.4	4.0	3.8	3.7	3.5	3.3	3.2	3.2	3.6	2.5	3.9
500 to 999		2.2	2.2	2.2	1.7	1.7	1.7	2.4	2.7	2.7	2.5	3.0
1,000 to 4,999		2.4	2.4	2.4	2.3	2.1	1.9	2.4	2.7	2.5	2.5	2.6
5,000 to 9,999		1.8	2.0	2.0	2.0	2.1	2.8	2.9	2.8	2.8	2.2	2.0
10,000 to 24,999		2.5	5.6	2.5	5.6	2.5	2.5	3.0	2.6	2.5	2.5	2.0
25,000 or more		3.5	3.7	3.8	3.7	3.7	3.6	3.8	4.0	3.7	3.6	3.1

NA = not available; SIC = Standard Industrial Classification

NOTES: As a result of a new sample design, statistics for 1988-91 have been revised since originally published. These statistics now better reflect R&D performance among firms in the nonmanufacturing industries and small firms in all industries. As a result of the new sample design, data for 1991 and later years are not directly comparable with data for 1990 and earlier years.

*Beginning with data from the 1995 survey (in which 1994 data were also collected), this table includes both manufacturing and nonmanufacturing companies. Only manufacturing companies were included in prior years.

SOURCE: National Science Foundation, Science Resources Studies Division, Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming).

See figure 4-11 and text table 4-4.

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Appendix table 4-26. Trends in R&D and federal outlays: FYs 1980, 1990, and proposed 1998

Composition of federal outlays	1980	1990	1998						
Billi	ions of current dollars								
Mandatory programs ^a	262.3	568.5	890.1						
Net interest	52.5	184.2	249.9						
Defense discretionary	134.6	300.1	260.1						
R&D outlays	15.0	41.6	38.3						
International discretionary	12.8	19.1	19.3						
R&D outlays	0.1	0.4	0.3						
Domestic discretionary 128.7 181.2 268.0 Nondefense R&D outlays 16.7 23.3 34.0									
Nondefense R&D outlays									
Total R&D	31.8	65.3	72.7						
	Percentages								
Total R&D/total federal outlays	5.4	5.2	4.3						
Nondefense R&D/total federal outlays	2.8	1.9	2.0						
Total R&D/total discretionary	11.5	13.0	13.3						
Nondefense R&D/domestic discretionary	13.0	12.9	12.7						

^aThese include Social Security, Medicare, Medicaid, and other programs.

See figure 4-12.

SOURCE: American Association for the Advancement of Science, Research and Development: FY 1998 (Washington, DC: 1997).

Appendix table 4-27. Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1987-97

				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		1		† 0)	0661	
				Millions of current dollars	rrent dollars						
TOTAL R&D											
	55,254	56,769	61,407	63,560	61,295	65,593	67,314	67,256	68,755	69,077	68,064
Dept. of Agriculture	948	7,0,1	1,038	1,108	1,237	1,327	1,328	1,400	1,380	1,352	1,369
	402	389	338	438	490	169	626	826	1,136	1,1/3	1,096
	35,232	35,249	37,577	37,268	32,135	36,130	35,849	34,566	34,362	34,284	32,964
Dept. of Education	133	141	159	1/0	1/1	169	1/8	1/1	1/8	182	188
Dept. of Energy	4,757	5,036	5,193	5,631	5,983	6,172	6,262	6,048	6,145	5,676	5,895
Dept. of Health & Human Services	9,606	7,158	7,903	8,406	9,756	8,988	10,349	11,022	11,455	11,914	12,185
Dept. of the Interior	404	417	469	209	593	609	619	694	262	565	574
Dept. of Justice	42	43	38	41	49	48	49	45	28	81	94
Dept. of Transportation	325	305	303	367	380	445	545	621	727	641	206
Dept. of the Treasury	27	56	26	56	31	25	17	19	61	64	64
Dept. of Veterans Affairs	210	215	235	238	217	224	236	248	238	276	258
Environmental Protection Agency	348	347	380	420	433	484	495	554	552	457	581
Agency for International Development	218	204	279	332	378	366	382	254	303	247	187
National Aeronautics & Space											
Administration	3,787	4,330	5,394	6,533	7,280	7,658	8,020	8,296	9,015	9,614	9,204
National Science Foundation	1,471	1,533	1,670	1,690	1,785	1,868	1,882	2,040	2,149	2,142	2,279
Nuclear Regulatory Commission	123	109	115	109	109	119	120	91	88	29	29
Smithsonian Institution	72	75	80	84	86	86	102	124	124	125	137
Tennessee Vallev Authority	78	87	63	65	89	97	109	86	93	103	77
All other agencies	73	88	87	125	104	116	116	134	130	122	148
BASIC DESEABOLD											
DASIC RESEARCH	0,0	7 7 7	7	000	7 7 7 7	000	000	0 1	000	700	700
lotal, all agencies	0,942	9,474	10,602	0,700	17,17	7,490	0,039	2,000	0,000	7,407	14,732
Dept. or Agriculture	446	184	485	50.6	228	292 101	010	909	282	280	909
Dept. of Commerce	56	31	29	31	34	35	37	40	66 .	38	68
Dept. of Defense	806	877	948	948	994	1,099	1,268	1,222	1,264	1,134	1,146
Dept. of Education	က	4	4	2	တ	∞	2	9	9	4	က
Dept. of Energy	1,069	1,185	1,411	1,505	1,687	1,736	1,755	1,603	1,634	1,957	2,035
Dept. of Health & Human Services	3,828	4,081	4,388	4,649	5,050	5,059	2,697	5,884	6,061	6,442	6,558
Dept. of the Interior	135	127	189	202	229	231	230	83	22	99	22
Dept. of Justice	∞	∞	7	6	9	2	2	9	∞	∞	12
Dept. of Transportation	0	0	0	0	0	-	2	က	47	46	54
Dept. of the Treasury	2	2	က	က	4	4	7	1	1	0	1
Dept. of Veterans Affairs	17	17	17	16	16	16	13	4	12	4	4
Environmental Protection Agency	31	27	51	74	91	110	88	101	20	99	75
Agency for International Development	က	က	က	2	9	9	80	2	2	2	2
National Aeronautics & Space											
Administration	1,014	1,113	1,417	1,637	1,706	1,738	1,800	1,964	1,978	2,009	1,885
National Science Foundation	1,371	1,433	1,563	1,586	1,676	1,742	1,744	1,871	1,973	1,968	2,090
Nuclear Regulatory Commission	0	0	0	0	0	0	0	0	0	0	0
Smithsonian Institution	72	75	80	84	86	86	102	124	124	125	137
Tennessee Valley Authority	4	က	က	2	2	2	10	6	6	12	0
All other agencies	2	4	4	4	2	9	1	14	17	16	15

Appendix table 4-27. Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1987-97

Agency	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
APPLIED RESEARCH											
Total, all agencies	8,998	9,177	10,164	10,337	11,798	12,001	13,491	13,888	14,678	14,096	14,441
Dept. of Agriculture	473	202	517	542	618	999	989	716	202	989	678
Dept. of Commerce	313	312	322	346	415	561	545	829	853	861	830
Dept. of Defense	2,440	2,362	2,708	2,582	2,724	2,975	3,515	3,040	3,070	2,814	2,716
Dept. of Education	104	107	118	125	123	120	128	131	133	138	140
Dept. of Energy	1,029	1,051	1,021	1,066	1,587	1,676	1,685	1,679	1,826	1,343	1,541
Dept. of Health & Human Services	2,194	2,416	2,700	2,818	3,112	2,887	3,496	3,853	4,015	4,083	4,210
Dept. of the Interior	247	566	253	270	324	340	320	292	477	484	489
Dept. of Justice	12	10	=	=	15	15	21	20	18	19	23
Dept. of Transportation	69	91	121	119	115	156	224	270	324	288	340
Dept. of the Treasury	13	Ξ	13	15	21	17	2	6	49	20	54
Dept. of Veterans Affairs	173	179	197	199	178	185	194	209	206	239	223
Environmental Protection Agency	246	241	223	242	262	294	272	301	331	286	336
Agency for International Development	151	132	216	300	352	294	351	214	270	224	168
National Aeronautics & Space											
Administration	1,256	1,219	1,461	1,424	1,666	1,491	1,749	1,877	2,068	2,272	2,356
National Science Foundation	66	100	108	103	109	127	138	170	176	174	189
Nuclear Regulatory Commission	123	109	115	109	109	119	120	91	88	29	29
Smithsonian Institution) C) :) C)) :) C	2	; C) C) C) C
Tennessee Velley Authority	, -	<u>τ</u>	. 5	10	17.0	00	, L	10	17	0 0) 7
All other adencies	- 4 - 43	. r.	49	49	- 22	27 92 92	45	45	2.5		7.7
	<u>)</u>	3	<u>)</u>	2))	<u>)</u>	2))	-
DEVELOPMENT											
Total, all agencies	37,313	38,119	40,641	41,937	37,327	41,102	40,424	39,815	40,181	40,499	38,890
Dept. of Agriculture	59	31	36	47	61	99	9/	27	80	80	82
Dept. of Commerce	64	47	47	61	40	22	74	108	244	275	227
Dept. of Defense	31,884	32,010	33,921	33,739	28,417	32,056	31,066	30,304	30,028	30,336	29,103
Dept. of Education	56	30	37	40	36	42	44	40	39	40	45
Dept. of Energy	2,659	2,801	2,761	3,060	2,710	2,760	2,822	2,766	2,685	2,376	2,320
Dept. of Health & Human Services	584	661	814	939	1,594	1,042	1,157	1,285	1,379	1,390	1,417
Dept. of the Interior	22	24	27	33	40	39	33	44	29	56	27
Dept. of Justice	23	56	21	21	28	28	23	19	32	54	29
Dept. of Transportation	256	213	183	247	265	288	319	347	356	307	311
Dept. of the Treasury	10	10	6	7	7	4	9	10	12	13	Ξ
Dept. of Veterans Affairs	19	19	21	22	23	23	29	25	19	22	22
Environmental Protection Agency	71	80	107	105	80	80	134	151	150	105	170
Agency for International Development	64	69	09	29	20	99	23	38	30	20	4
National Aeronautics & Space											
Administration	1,518	1,999	2,515	3,473	3,909	4,428	4,471	4,456	4,969	5,332	4,964
National Science Foundation	0	0	0	0	0	0	0	0	0	0	0
Nuclear Regulatory Commission	0	0	0	0	0	0	0	0	0	0	0
Smithsonian Institution	0	0	0	0	0	0	0	0	0	0	0
Tennessee Valley Authority	09	69	48	43	20	73	81	72	29	72	63
All other agencies	56	31	34	72	46	53	61	74	62	51	22
Dog 2 of 7											

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Appendix table 4-27. Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1987-97

Agency	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
R&D PLANT											
Total, all agencies	1,846	2,057	2,165	2,272	2,853	2,985	3,101	2,171	2,257	1,971	2,085
Dept. of Agriculture	112	135	88	102	145	165	142	126	143	150	125
Dept. of Commerce	S	- ;	ာ	15	16	21	25	31	78	80	106
Dept. of Defense	477	436	499	487	426	397	372	222	65	82	40
Dept. of Education	21	<u>.</u> د	2	<u>ာ</u>	4	2	7	7	2	0	0
Dept. of Energy	772	915	873	916	1,220	1,321	1,462	912	745	756	826
Dept. of Health & Human Services	37	20	79	108	98	26	149	120	256	304	429
Dept. of the Interior	12	တ	Ξ	4	22	18	23	တ	7	2	7
Dept. of Justice	1	0	0	0	0	0	0	0	0	0	0
Dept. of Transportation	-	14	16	22	18	25	32	41	29	59	23
Dept. of the Treasury	0	0	0	0	0	0	0	0	0	0	0
Dept. of Veterans Affairs	9	20	Ξ	က	က	9	က	12	7	4	4
Environmental Protection Agency	0	0	0	0	0	0	က	2	2	2	2
Agency for International Development	7	9	0	0	0	0	0	0	0	0	0
National Aeronautics & Space											
Administration	309	428	520	527	724	818	749	515	625	333	315
National Science Foundation	61	22	54	39	160	102	130	172	290	219	200
Nuclear Regulatory Commission	0	0	0	0	0	0	0	0	0	0	0
Smithsonian Institution	er.	· -	ı co	ı.C	۰ ۵	4	יני	ı.c	ı rc	ı rc	ı rc
Tennessee Valley Authority) C	. c	o C	י ער	וע	۳.	· -) C	· -) -) C
All other agencies	- c	0 0	o c	6	, c , c	o		o c	- c	- c	0 0
)	•) -) I	-	-)))	Ò
R&D AND R&D PLANT											
Total, all agencies	57,100	58,827	63,572	65,831	64,148	68,577	70,415	69,427	71,012	71,048	70,149
Dept. of Agriculture	1,060	1,152	1,128	1,211	1,381	1,492	1,470	1,525	1,523	1,502	1,494
Dept. of Commerce	408	400	407	454	202	672	682	857	1,214	1,252	1,201
Dept. of Defense	35,709	35,685	38,076	37,756	32,561	36,526	36,221	34,788	34,427	34,369	33,004
Dept. of Education	154	146	161	179	175	171	180	178	179	182	188
Dept. of Energy	5,529	5,951	990'9	6,547	7,203	7,493	7,724	096'9	068'9	6,432	6,721
Dept. of Health & Human Services	6,643	7,178	7,981	8,513	9,842	9,085	10,499	11,142	11,711	12,218	12,614
Dept. of the Interior	416	426	480	523	615	628	642	703	568	568	581
Dept. of Justice	54	43	38	41	49	48	49	45	28	81	94
Dept. of Transportation	336	319	319	388	398	470	218	662	756	671	728
Dept. of the Treasury	27	56	56	26	31	25	17	19	62	64	65
Dept. of Veterans Affairs	215	235	246	241	220	230	240	260	245	280	262
Environmental Protection Agency	348	347	380	420	433	484	498	558	256	462	286
Agency for International Development	224	211	279	335	378	366	382	254	303	247	187
National Aeronautics & Space											
Administration	4,097	4,759	5,913	7,060	8,004	8,475	8,769	8,812	9,640	9,946	9,519
National Science Foundation	1,532	1,590	1,724	1,729	1,945	1,970	2,012	2,212	2,439	2,361	2,479
Nuclear Regulatory Commission	123	109	115	109	109	119	120	91	88	29	29
Smithsonian Institution	74	92	84	88	100	102	107	129	129	130	142
Tennessee Valley Authority	78	88	63	20	73	101	110	86	94	104	77
All other agencies	74	88	87	144	127	122	117	134	130	122	148
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Appendix table 4-27. Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1987-97

Agency	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
			Milli	Millions of constant 1992 dollars	ant 1992 dol	lars					
TOTAL R&D											
Total, all agencies	66,651	66,165	68,687	68,197	63,061	65,593	62,608	64,053	63,899	62,740	60,287
Dept. of Agriculture	1,143 785	1,185	ן 16ר,ר 147	1,189	2/2,L	1,327	4,294 400,1	1,333	1,282	1,228	212,1 579
Dept. of Defense	407	41 083	42 032	39 987	33,060	36 130	34 941	32 920	31 935	31 139	29 198
Dept. of Education	160	164	178	182	176	169	173	168	165	165	167
Dept. of Energy	5.738	5.870	5.808	6,041	6.155	6.172	6.103	5.760	5.711	5.155	5.222
Dept. of Health & Human Services	7,969	8,343	8,840	9,019	10,037	8,988	10,087	10,497	10,646	10,821	10,793
Dept. of the Interior	487	486	525	546	610	609	603	661	522	513	508
Dept. of Justice	51	20	43	43	20	48	48	43	54	73	83
Dept. of Transportation	392	355	339	393	391	445	531	591	929	583	625
Dept. of the Treasury	32	30	59	27	32	25	16	18	25	28	22
Dept. of Veterans Affairs	253	251	263	255	223	224	230	236	221	251	229
Environmental Protection Agency	420	405	425	450	445	484	483	527	513	415	515
Agency for International Development	262	238	312	359	389	366	373	242	281	224	165
National Aeronautics & Space											
Administration	4,568	5,047	6,033	7,010	7,490	7,658	7,817	7,901	8,378	8,732	8,153
National Science Foundation	1,774	1,786	1,868	1,813	1,837	1,868	1,834	1,943	1,997	1,945	2,019
Nuclear Regulatory Commission	148	126	128	117	112	119	117	86	85	54	52
Smithsonian Institution	86	88	06	06	101	86	66	118	115	114	121
Tennessee Valley Authority	94	102	20	20	20	26	106	93	87	94	89
All other agencies	88	103	86	134	107	116	113	128	121	111	131
BASIC RESEARCH											
Total, all agencies	10,787	11,041	11,859	12,109	12,521	12,490	13,060	12,908	12,914	13,154	13,049
Dept. of Agriculture	537	260	542	222	574	595	009	577	553	533	538
Dept. of Commerce	31	36	33	34	35	35	36	38	37	34	34
Dept. of Defense	1,095	1,022	1,060	1,017	1,023	1,099	1,236	1,164	1,175	1,030	1,015
Dept. of Education	4	2	2	2	6	80	2	2	2	က	က
Dept. of Energy	1,289	1,381	1,578	1,615	1,735	1,736	1,710	1,527	1,519	1,777	1,802
Dept. of Health & Human Services	4,617	4,757	4,908	4,988	5,196	5,059	5,552	5,604	5,633	5,851	5,809
Dept. of the Interior	163	147	211	220	236	231	224	79	51	21	20
Dept. of Justice	10	o	∞	တ	7	2	2	9	∞	∞	-
Dept. of Transportation	0	0	0	0	0	-	2	က	44	42	48
Dept. of the Treasury	9	9	4	4	4	4	9	0	0	0	0
Dept. of Veterans Affairs	21	20	19	17	17	16	13	14	12	13	12
Environmental Protection Agency	38	32	22	79	94	110	87	26	92	09	29
Agency for International Development	က	က	က	2	9	9	∞	2	2	2	4
National Aeronautics & Space											
Administration	1,223	1,297	1,585	1,756	1,755	1,738	1,754	1,870	1,838	1,825	1,670
National Science Foundation	1,654	1,670	1,748	1,702	1,724	1,742	1,700	1,782	1,834	1,787	1,851
Nuclear Regulatory Commission	0	0	0	0	0	0	0	0	0	0	0
Smithsonian Institution	86	88	06	06	101	86	66	118	115	114	121
Tennessee Valley Authority	2	4	က	2	Ν,	7	0 1	∞ ;	∞ !	Ξ:	0 ;
All other agencies	9	2	2	2	9	9	Ξ	13	15	4	4
7 30 7 05 7											

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Appendix table 4-27. Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1987-97

Agency	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
APPLIED RESEARCH		L ()			1 7	0	1	000	3	0	1
Total, all agencies	10,854	10,695	11,369	11,091	12,137	12,001	13,150	13,226	13,641	12,803	12,791
Dept. of Agriculture	571	288	579	582	636	999	620	682	655	623	601
Dept. of Commerce	377	363	360	371	427	561	531	646	793	782	735
Dept. of Defense	2,943	2,753	3,029	2,770	2,802	2,975	3,426	2,895	2,853	2,556	2,405
Dept. of Education	125	124	131	134	127	120	125	125	123	126	124
Dept. of Energy	1,242	1,224	1,142	1,143	1,633	1,676	1,643	1,599	1,697	1,220	1,365
Dept. of Health & Human Services	2,647	2,815	3,021	3,024	3,202	2,887	3,407	3,669	3,731	3,709	3,729
Dept. of the Interior	298	310	283	289	333	340	341	540	444	439	433
Dept. of Justice	4	=======================================	12	12	15	15	20	19	16	17	20
Dept. of Transportation	83	106	135	128	118	156	219	258	301	262	301
Dept. of the Treasury	15	13	15	16	21	17	4	6	45	46	48
Dept. of Veterans Affairs	209	208	220	214	183	185	189	199	192	217	197
Environmental Protection Agency	297	281	249	259	269	294	265	287	308	260	297
Agency for International Development	182	154	242	322	362	294	342	204	251	204	149
National Aeronautics & Space											
Administration	1,514	1,421	1,635	1,528	1,714	1,491	1,704	1,787	1,922	2,064	2,086
National Science Foundation	120	116	121	111	112	127	135	162	164	158	168
Nuclear Regulatory Commission	148	126	128	117	112	119	117	86	82	54	52
Smithsonian Institution	0	0	0	0	0	0	0	0	0	0	0
Tennessee Valley Authority	17	18	13	18	17	22	18	16	16	18	13
All other agencies	52	62	22	52	54	26	44	43	48	20	89
DEVELOPMENT											
Total, all agencies	45.010	44.428	45.460	44.997	38.402	41.102	39,399	37.919	37.343	36.784	34.447
Dept. of Agriculture	35	37	40	51	63	99	74	74	75	73	73
Dept. of Commerce	77	54	52	99	4	22	72	103	226	249	201
Dept. of Defense	38,461	37,307	37,943	36,201	29,235	32,056	30,278	28,861	27,907	27,553	25,778
Dept. of Education	31	35	42	43	41	42	43	38	37	36	40
Dept. of Energy	3,208	3,265	3,088	3,283	2,788	2,760	2,750	2,634	2,495	2,158	2,055
Dept. of Health & Human Services	705	771	911	1,007	1,639	1,042	1,127	1,224	1,282	1,262	1,255
Dept. of the Interior	56	28	30	36	41	39	38	42	27	23	24
Dept. of Justice	27	30	23	22	59	28	23	18	30	49	52
Dept. of Transportation	309	249	205	265	273	288	311	331	331	279	276
Dept. of the Treasury	Ξ	12	10	7	7	4	2	တ	12	12	စ
Dept. of Veterans Affairs	23	22	23	24	23	23	28	23	18	20	19
Environmental Protection Agency	86	93	120	112	82	80	130	144	139	92	151
Agency for International Development	77	81	29	31	21	99	22	36	28	18	12
National Aeronautics & Space											
Administration	1,831	2,330	2,813	3,726	4,022	4,428	4,358	4,244	4,618	4,843	4,396
National Science Foundation	0	0	0	0	0	0	0	0	0	0	0
Nuclear Regulatory Commission	0	0	0	0	0	0	0	0	0	0	0
Smithsonian Institution	0	0	0	0	0	0	0	0	0	0	0
Tennessee Valley Authority	73	80	54	46	51	73	79	89	62	99	26
All other agencies	31	36	38	77	47	53	29	71	25	46	49
1											

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Appendix table 4-27. Federal obligations for R&D and R&D plant, by agency and character of work: FYs 1987-97

Agency	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
R&D PLANT	1		0	7	C	C	0	0	0	0	7
lotal, all agencies	7,22,7	7,590	2,422	7,437	7,935 7,935	7,885	3,022	7,000 7,000	7,037	1,790	7,04,
Dept. of Agriculture	င်္ဂ	00.	90.	⊇ ! -	- 5 0	60	90°	021	2 1	20	_ 6
Dept. of Commerce	ِ ٥	5	0	/L	91	17	52	30	7.7	7.7	S .
Dept. of Defense	929	208	259	523	438	397	362	211	61	77	35
Dept. of Education	25	9	2	10	4	2	2	2	2	0	0
Dept. of Energy	931	1,066	977	983	1,255	1,321	1,424	898	692	989	732
Dept. of Health & Human Services	44	23	88	116	88	26	146	114	238	276	380
Dept. of the Interior	4	=	12	15	23	18	23	6	9	2	9
Dept. of Justice	13	0	0	0	0	0	0	0	0	0	0
Dept. of Transportation	4	16	17	23	19	25	31	39	27	26	20
Dept. of the Treasury	0	0	0	0	0	0	0	0	0	0	0
Dept. of Veterans Affairs	7	23	12	4	က	9	က	1	7	က	4
Environmental Protection Agency	0	0	0	0	0	0	2	2	4	4	4
Agency for International Development	80	7	0	0	0	0	0	0	0	0	0
National Aeronautics & Space											
Administration	373	499	581	565	744	818	730	491	581	302	279
National Science Foundation	74	99	09	42	164	102	127	164	269	199	177
Nuclear Regulatory Commission	0	0	0	0	0	0	0	0	0	0	0
Smithsonian Institution	က	-	4	2	2	4	2	5	2	2	4
Tennessee Valley Authority	0	0	0	2	5	က	-	0	-	•	0
All other agencies	-	0	0	20	23	7	-	0	0	0	0
R&D AND R&D PLANT											
	878 878	68 562	71 109	70.634	65 996	68 577	68 630	66 121	65 996	64 530	62 133
	00,070	20,302	7,100	1,000	00,700	00,00	00,00	00,121	00,330	0,70	02,133
Dept. of Agriculture	1,278	1,342	1,261	1,299	1,421	1,492	1,433	1,453	1,416	1,364	1,323
Dept. of Commerce	492	466	455	487	520	672	664	816	1,128	1,138	1,064
Dept. of Defense	43,074	41,590	42,591	40,510	33,498	36,526	35,303	33,131	31,996	31,216	29,233
Dept. of Education	185	170	180	192	180	171	175	170	167	165	167
Dept. of Energy	6,670	6,936	6,785	7,024	7,411	7,493	7,528	6,628	6,403	5,842	5,953
Dept. of Health & Human Services	8,013	8,366	8,928	9,135	10,126	9,085	10,232	10,611	10,884	11,097	11,173
Dept. of the Interior	501	497	537	561	633	628	626	029	528	515	514
Dept. of Justice	65	20	43	43	20	48	48	43	54	73	83
Dept. of Transportation	406	371	357	417	410	470	563	630	702	609	645
Dept. of the Treasury	33	31	59	28	32	25	16	18	22	28	22
Dept. of Veterans Affairs	260	274	275	259	226	230	233	247	228	254	232
Environmental Protection Agency	420	405	425	450	445	484	485	532	517	420	519
Agency for International Development	271	245	312	329	389	366	373	242	281	224	165
National Aeronautics & Space											
Administration	4,941	5,546	6,614	7,575	8,234	8,475	8,547	8,392	8,959	9,034	8,431
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Appendix table 4-27. FYs and R&D plant, by agency and character of work: FYs 1987-97

Agency	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
National Science Foundation	1,848	1,853	1,928	1,855	2,001	1,970	1,961	2,107	2,267	2,144	2,196
Nuclear Regulatory Commission	148	126	128	117	112	119	117	86	82	54	52
Smithsonian Institution	06	88	94	96	102	102	104	123	120	118	126
Tennessee Valley Authority	94	102	70	75	75	101	107	93	87	92	89
All other agencies	06	103	26	154	130	122	114	128	121	111	131

NOTE: See appendix table 4-1 for GDP implicit price deflators used to convert current dollars to constant 1992 dollars.

SOURCES: National Science Foundation, Science Resources Studies Division (NSF/SRS), Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1997).

VA: 1996); and NSF/SRS, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997).

See figures 4-13 and 4-14 and text table 4-7.

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Appendix table 4-28. **Department of Defense basic research funding: FYs 1996-2001**(Millions of dollars)

	1996	1997	1998	1999	2000	2001
Total Department of Defense	1,126	1,156	1,218	1,270	1,317	1,361
Total, services	787	825	858	897	934	970
Army	186	204	215	224	236	246
In-house laboratory independent research	14	15	16	17	18	19
Defense research sciences	125	142	147	153	162	167
University and industry research centers	47	47	52	54	57	60
Navy	377	387	403	428	449	470
In-house laboratory independent research	15	15	17	17	17	18
Defense research sciences	362	372	386	411	432	452
Air Force (Defense research sciences)	224	234	240	245	249	254
Total, Defense agencies	339	331	360	373	383	391
Chemical and biological defense programs	27	29	26	27	28	29
Office of the Secretary of Defense	234	227	259	270	277	285
In-house laboratory independent research	3	2	1	1	0	0
University research initiatives	222	209	237	247	255	262
Focused research initiatives	9	16	21	22	22	23
Advanced Research Projects Agency						
(Defense research sciences)	78	75	75	76	78	77

SOURCE: Department of Defense, Basic Research Plan (Washington, DC: 1996).

Appendix table 4-29. Estimated federal obligations for R&D, by selected agency, performer, and character of work: FY 1997 (Millions of current dollars)

				FFRDCs	Universities	FFRDCs		FFRDCs		
Agency	Total	Federal intramural	Industrial firms	administered by industry	and colleges	administered by U&C	Other nonprofit	administered by nonprofits	State and local govt.	Foreign
				Total R&D						
Total, all agencies	68,064	16,404	30,713	1,340	12,362	3,231	2,884	644	282	206
Dept. of Agriculture	1,369	922	12	0	421	0	7	0	2	4
Dept. of Commerce	1,096	712	303	0	71	*	9	0	က	-
Dept. of Defense	32,964	7,919	22,625	155	1,288	203	351	363	0	61
Dept. of Energy	5,895	202	1,516	933	574	2,035	69	233	4	14
Dept. of Health & Human Services	12,185	2,362	222	227	7,088	21	1,734	21	129	46
Dept. of the Interior	574	208	16	*	48	*	*	0	*	-
Dept. of Transportation	902	239	264	2	29	6	27	7	91	*
Environmental Protection Agency	581	237	158	0	132	0	43	0	7	4
National Aeronautics & Space Admin	9,204	2,301	5,063	0	708	804	275	4	က	47
National Science Foundation	2,279	19	125	*	1,824	145	156	-	2	2
All other agencies	1,212	229	22	24	142	13	216	16	27	23
			_	Basic research						
Total, all agencies	14,732	2,668	1,279	368	7,405	1,520	1,270	83	92	47
Dept. of Agriculture	809	395	7	0	199	0	4	0	-	2
Dept. of Commerce	39	34	-	0	4	*	*	0	0	0
Dept. of Defense	1,146	293	153	-	647	4	39	*	0	တ
Dept. of Energy	2,035	69	103	241	440	1,096	14	70	2	-
Dept. of Health & Human Services	6,558	1,142	270	126	3,928	17	973	Ξ	64	27
Dept. of the Interior	22	51	0	0	9	0	*	0	0	0
Dept. of Transportation	54	*	20	*	-	*	12	0	21	0
Environmental Protection Agency	22	31	20	0	17	0	9	0	-	*
National Aeronautics & Space Admin	1,885	471	614	0	480	257	99	-	_	က
National Science Foundation	2,090	18	06	*	1,680	145	149	*	က	4
All other agencies	186	164	0	0	4	0	17	-	-	-
			A	Applied research	٦					
Total, all agencies	14,441	5,028	3,521	289	3,418	611	930	109	115	73
Dept. of Agriculture	678	449	9	0	218	0	ဇ	0	-	2
Dept. of Commerce	830	909	152	0	64	*	4	0	က	-
Dept. of Defense	2,716	1,073	1,192	80	321	92	39	14	0	2
Dept. of Energy	1,541	183	173	529	93	439	36	69	9	13
Dept. of Health & Human Services	4,210	1,047	222	9/	2,204	က	579	o	99	14
Dept. of the Interior	489	441	9	*	4	*	*	0	*	-
Dept. of Transportation	340	148	110	-	29	7	1	-	36	*
Environmental Protection Agency	335	137	91	0	9/	0	25	0	4	7
National Aeronautics & Space Admin	2,356	289	1,485	0	107	06	71	-	-	12
National Science Foundation	189	-	34	0	144	*	9	0	7	2
All other agencies	757	326	20	23	120	13	153	16	9	22
Dozo 1 of 0										

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Appendix table 4-29. Estimated federal obligations for R&D, by selected agency, performer, and character of work: FY 1997 (Millions of current dollars)

Agency	Total	Federal intramural	Industrial firms	FFRDCs administered by industry	Universities and colleges	FFRDCs administered by U&C	Other nonprofit	FFRDCs administered by nonprofits	State and local govt.	Foreign
				Development						
Total, all agencies	38,890	8,708	25,913	334	1,539	1,099	684	453	75	87
Dept. of Agriculture	82	78	0	0	4	0	*	0	*	*
Dept. of Commerce	227	73	150	0	က	0	-	0	0	-
Dept. of Defense	29,103	6,553	21,280	146	320	134	274	349	0	48
Dept. of Energy	2,320	255	1,240	163	41	501	19	94	9	*
Dept. of Health & Human Services	1,417	173	92	25	955	-	182	-	10	4
Dept. of the Interior	27	16	10	0	-	0	0	0	0	0
Dept. of Transportation	311	91	134	-	37	9	_	9	35	*
Environmental Protection Agency	170	69	46	0	39	0	13	0	2	-
National Aeronautics & Space Admin	4,964	1,241	2,963	0	120	457	147	2	-	32
National Science Foundation	0	0	0	0	0	0	0	0	0	0
All other agencies	268	157	25	0	19	0	47	0	21	-

^{* =} less than \$500,000; FFRDCs = federally funded research and development centers; U&C = universities and colleges

See text table 4-6.

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NOTES: These figures reflect funding levels as reported by federal agencies in March through October 1996.

SOURCE: National Science Foundation, Science Resources Studies Division, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997).

Appendix table 4-30. Federal obligations for R&D, by character of work and performer: FYs 1987-97

Character of work and performer	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996(est.)	1997(est.)
			Millions	of current dollars	dollars						
Total R&D	55,253	56,769	61,406	63,667	61,295	65,592	67,314	67,256	68,755	69,077	68,064
Federal intramural ^a	13,413	14,115	15,121	16,002	15,238	15,690	16,556	16,139	17,343	16,897	16,404
Industrial firms excluding FFRDCs	26,768	26,719	28,548	29,378	26,421	29,745	30,326	30,454	30,469	31,268	30,713
FFRDCs administered by industry	1,860	1,911	1,960	2,237	2,068	2,010	1,451	1,294	1,204	1,231	1,340
Universities and colleges excluding FFRDCs	7,337	7,828	8,672	9,142	10,169	10,271	11,156	11,829	11,933	12,251	12,362
FFRDCs administered by universities	3,210	3,474	3,497	3,466	3,604	3,856	3,666	3,293	3,574	3,302	3,231
Nonprofit institutions excluding FFRDCs	1,711	1,683	1,999	2,249	2,637	2,804	2,811	2,930	2,807	2,867	2,884
FFRDCs administered by nonprofit institutions	511	909	522	632	629	746	753	736	831	721	644
State and local government	148	142	167	214	215	184	320	325	317	274	282
Foreign	296	392	919	345	264	288	272	257	278	266	206
Basic research	8,942	9,474	10,602	11,286	12,171	12,490	13,399	13,553	13,895	14,482	14,732
Federal intramural ^a	2,046	2,050	2,371	2,366	2,447	2,397	2,605	2,505	2,713	2,414	2,668
Industrial firms excluding FFRDCs	467	265	773	888	950	920	959	1,109	1,221	1,226	1,279
FFRDCs administered by industry	120	133	167	175	209	188	237	238	239	340	368
Universities and colleges excluding FFRDCs	4,666	4,868	5,221	5,548	6,065	6,332	6,799	7,024	6,951	7,754	7,405
FFRDCs administered by universities	206	066	1,098	1,228	1,306	1,394	1,438	1,336	1,438	1,504	1,520
Nonprofit institutions excluding FFRDCs	658	729	839	924	1,016	1,097	1,165	1,126	1,134	1,062	1,270
FFRDCs administered by nonprofit institutions	13	18	42	29	81	9	71	74	22	72	83
State and local government	38	43	44	20	49	42	72	75	62	20	92
Foreign	59	46	47	48	49	54	23	99	42	41	47
Applied research	8,998	9,176	10,163	10,453	11,798	12,001	13,491	13,887	14,678	14,096	14,441
Federal intramurala	3,392	3,288	3,611	3,587	4,093	4,219	4,755	4,983	5,075	4,990	5,028
Industrial firms excluding FFRDCs	1,982	2,046	2,102	2,312	2,457	2,531	3,060	2,954	3,507	3,447	3,521
FFRDCs administered by industry	314	322	353	367	416	405	229	200	629	538	637
Universities and colleges excluding FFRDCs	1,975	2,155	2,572	2,593	2,803	2,729	3,046	3,299	3,420	3,166	3,418
FFRDCs administered by universities	264	575	909	581	855	928	910	845	797	582	611
Nonprofit institutions excluding FFRDCs	220	571	681	738	910	952	876	696	922	1,039	930
FFRDCs administered by nonprofit institutions	77	92	29	88	06	74	102	104	135	112	109
State and local government	23	09	78	92	80	29	140	156	143	129	115
Foreign	93	94	92	109	94	99	44	77	100	93	73
Development	37,313	38,119	40,640	41,929	37,327	41,102	40,424	39,815	40,181	40,499	38,890
Federal intramurala	7,975	8,776	9,139	10,049	8,699	9,074	9,196	8,651	9,555	9,493	8,708
Industrial firms excluding FFRDCs	24,320	24,077	25,673	26,178	23,014	26,294	26,307	26,391	25,741	26,595	25,913
FFRDCs administered by industry	1,426	1,456	1,440	1,695	1,444	1,417	655	226	386	354	334
Universities and colleges excluding FFRDCs	269	805	879	1,001	1,301	1,211	1,312	1,505	1,561	1,331	1,539
FFRDCs administered by universities	1,739	1,909	1,794	1,658	1,443	1,504	1,319	1,112	1,339	1,216	1,099
Nonprofit institutions excluding FFRDCs	503	383	480	285	712	754	771	835	750	992	684
FFRDCs administered by nonprofit institutions	421	423	412	484	509	909	280	558	621	538	453
State and local government	28	39	46	88	86	22	108	92	92	75	75
Foreign	173	251	777	188	121	168	175	113	133	132	87
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Appendix table 4-30. Federal obligations for R&D, by character of work and performer: FYs 1987-97

Character of work and performer	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996(est.)	1997(est.)
			Millions of	constant 1992 dollars	92 dollars						
Total R&D	66,650	66,164	68,687	68,312	63,061	65,592	65,608	64,053	63,899	62,740	60,287
Federal intramural ^a	16,180	16,451	16,914	17,170	15,677	15,690	16,136	15,371	16,118	15,347	14,529
Industrial firms excluding FFRDCs	32,290	31,141	31,933	31,521	27,182	29,745	29,558	29,004	28,317	28,399	27,203
FFRUCS administered by Industry	2,244 8,850	2,227	2,192	2,400	2,128	2,010	1,414	1,232	11,-19	1,118	1,180
CHIVE Stries and colleges exclading 11 nDCs FFRDCs administered by universities	3,872	9,124 4.049	3,700	3,719	3,402	3.856	3,573	3 136	3,322	9 999	2,850
Nonprofit institutions excluding FFRDCs	2.064	1,962	2.236	2,413	2.713	2.804	2.740	2,790	2,022	2,604	2.554
FFRDCs administered by nonprofit institutions	616	290	584	678	669	746	734	700	773	655	571
State and local government	179	166	187	230	221	184	312	310	294	249	249
Foreign	357	457	1,028	370	272	288	265	244	258	242	182
Basic research	10,786	11,042	11,859	12,109	12,522	12,490	13,059	12,907	12,914	13,154	13,049
Federal intramurala	2,468	2,389	2,652	2,539	2,517	2,397	2,539	2,386	2,521	2,192	2,363
Industrial firms excluding FFRDCs	263	969	865	953	226	920	935	1,056	1,135	1,113	1,133
FFRDCs administered by industry	145	155	187	188	215	188	231	226	222	309	326
Universities and colleges excluding FFRDCs	5,628	5,674	5,840	5,953	6,240	6,332	6,627	069'9	6,460	7,042	6,559
FFRDCs administered by universities	1,094	1,154	1,228	1,318	1,344	1,394	1,402	1,272	1,337	1,366	1,346
Nonprofit institutions excluding FFRDCs	793	820	938	991	1,045	1,097	1,135	1,072	1,054	965	1,125
FFRDCs administered by nonprofit institutions	16	21	47	63	83	65	69	20	20	65	73
State and local government	45	20	49	54	20	42	70	72	73	64	82
Foreign	32	54	53	25	20	54	25	63	4	38	4
Applied research	10,854	10,695	11,368	11,216	12,138	12,001	13,149	13,226	13,641	12,803	12,791
Federal intramurala	4,091	3,832	4,039	3,849	4,211	4,219	4,635	4,746	4,716	4,533	4,454
Industrial firms excluding FFRDCs	2,391	2,385	2,351	2,481	2,528	2,531	2,982	2,814	3,259	3,131	3,118
FFRDCs administered by industry	378	375	395	394	428	405	545	476	538	488	564
Universities and colleges excluding FFRDCs	2,382	2,512	2,877	2,782	2,884	2,729	2,969	3,142	3,179	2,876	3,027
FFRDCs administered by universities	681	029	229	623	880	928	887	805	741	529	542
Nonprofit institutions excluding FFRDCs	663	999	762	792	936	952	854	923	857	944	823
FFRDCs administered by nonprofit institutions	92	92	75	92	93	74	66	66	125	102	96
State and local government	64	70	87	82	82	29	136	148	133	117	102
Foreign	112	110	106	117	26	99	43	74	93	84	64
Development	45,009	44,428	45,459	44,988	38,402	41,102	39,400	37,919	37,343	36,784	34,447
Federal intramurala	9,620	10,228	10,223	10,782	8,950	9,074	8,963	8,239	8,880	8,622	7,713
Industrial firms excluding FFRDCs	29,337	28,062	28,717	28,088	23,677	26,294	25,640	25,134	23,923	24,155	22,952
FFRDCs administered by industry	1,721	1,697	1,611	1,819	1,486	1,417	638	530	329	321	296
Universities and colleges excluding FFRDCs	841	938	983	1,074	1,338	1,211	1,279	1,434	1,451	1,209	1,363
FFRDCs administered by universities	2,097	2,225	2,007	1,779	1,485	1,504	1,286	1,059	1,244	1,105	974
Nonprofit institutions excluding FFRDCs	209	446	237	630	733	754	751	262	269	695	909
FFRDCs administered by nonprofit institutions	208	493	461	519	524	909	292	531	222	488	401
State and local government	20	45	51	94	88	75	105	06	88	89	99
Foreign	209	293	869	202	124	168	171	108	124	120	77
Page 2 of 3											

Federal obligations for R&D, by character of work and performer: FYs 1987-97 Appendix table 4-30.

FFRDCs = federally funded research and development centers

NOTE: See appendix table 4-1 for GDP implicit price deflators used to convert current dollars to constant 1992 dollars.

Federal intramural activities cover costs associated with the planning and administration of intramural and extramural programs by federal personnel and actual intramural performance.

SOURCES: National Science Foundation, Science Resources Studies Division (NSF/SRS), Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1997).

VA: 1996); and NSF/SRS, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997).

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Appendix table 4-31. Federal R&D obligations for federal intramural performance, by selected agency: FYs 1980-97 (Millions of current dollars)

	ΠΔ								All other
	agencies	Defense	Energy	NASA	HHS	USDA	Commerce	Interior	agencies
1980	7,632	3,796	474	965	820	457	226	242	653
1981	8,426	4,281	451	1,044	872	511	237	274	756
1982	9,141	5,139	176	1,166	946	531	242	261	089
1983	10,582	6,401	258	1,134	1,034	229	252	274	670
1984	11,572	7,257	216	1,043	1,066	589	256	334	811
1985	12,945	8,324	224	1,171	1,147	628	280	342	830
1986	13,535	8,881	206	1,217	1,236	630	285	332	749
1987	13,413	8,336	248	1,414	1,293	649	320	355	662
1988	14,115	8,880	245	1,335	1,408	694	316	353	883
1989	15,121	9,295	248	1,733	1,529	689	325	394	206
1990	16,003	6,639	307	1,968	1,662	737	336	424	929
1991	15,238	8,157	381	2,112	1,975	824	400	490	006
1992	15,690	8,601	336	2,210	1,783	862	512	513	872
1993	16,556	8,742	517	2,295	2,033	898	200	522	1,080
1994	16,139	8,017	562	2,271	2,206	931	265	595	626
1995	17,343	8,907	491	2,254	2,485	915	999	492	1,135
1996 (est.)	16,897	8,655	416	2,403	2,240	868	889	493	1,104
1997 (est.)	16,404	7,919	202	2,301	2,362	922	712	508	1,172

HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; USDA = Department of Agriculture

NOTE: Intramural activities cover costs associated with the planning and administration of intramural and extramural R&D programs by federal personnel and actual intramural R&D performance.

SOURCES: National Science Foundation, Science Resources Studies Division (NSF/SRS), Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1997).

See text table 4-7.

Appendix table 4-32. Federal R&D laboratory campuses, by agency and state: FY 1995

Fodoval account	Number of laboratory	1995	Chata	Number of laboratory	1995
Federal agency	campuses	(millions)	State T	campuses	(millions)
Total	. 515	26,578.8	Total	515	26,578.8
Department of Agriculture	. 185	733.4	Alabama	11	992.3
Agricultural Research Service	. 107	556.1	Alaska	10	33.8
Forest Service	. 78	177.3	Arizona	8	125.2
Department of Commerce		430.3	Arkansas		32.1
Nat. Inst. of Standards & Tech		199.9	California		4,119.7
Nat. Oceanic & Atmos. Admin		230.4	Colorado		575.3
Department of Defense		9,150.8	Connecticut		18.6
Dept. of the Air Force		1,824.0	Delaware		1.0
Dept. of the Army		2,076.3	Florida		848.6
Dept. of the Navy		4,668.2	Georgia		132.8
Other Defense agencies		582.3	Hawaii		21.2
Department of Education		41.0	Idaho		816.9
Department of Energy		8,080.7	Illinois		727.7
Defense Programs		3,203.3	Indiana		11.3
Energy research		2,670.6	lowa		64.8
Energy efficiency & renewable		237.6	Kansas		6.8
		904.0			2.6
Environmental management			Kentucky		
Fossil energy		445.7	Louisiana		39.8
Naval reactors		585.0	Maine		0.4
Nonproliferation		5.0	Maryland		2,921.2
Office of the Sec. of Energy		29.5	Massachusetts		1,005.3
Dept. of Health & Human Services		1,371.4	Michigan		101.8
Centers for Disease Ctrl. & Prev		108.6	Minnesota		33.9
Food and Drug Administration ^a		40.2	Mississippi		285.1
National Institutes of Health		1,222.6	Missouri		71.4
Department of the Interior		547.4	Montana		21.0
Bureau of Reclamation		71.3	Nebraska		19.9
National Biological Service		105.1	Nevada		28.4
U.S. Geological Survey		371.0	New Hampshire		31.4
Department of Justice—DEA		1.0	New Jersey		592.1
Department of Transportation		536.2	New Mexico		2,692.5
Federal Aviation Administration		211.7	New York		680.1
Federal Highway Administration		125.5	North Carolina		240.4
Nat. Highway Traf. Safety Admin		8.0	North Dakota	5	24.6
Research & Spec Prog Admin		198.2	Ohio	12	705.2
Department of the Treasury-IRS		1.5	Oklahoma	10	142.3
Department of Veterans Affairs	. 102	270.0	Oregon	14	83.3
Environ. Protection Agency (R&D)		348.2	Pennsylvania	14	578.7
Nat. Aeronautics & Space Admin	. 10	4,832.7	Rhode Island	5	416.3
Aeronautics	. 4	1,369.7	South Carolina	10	122.2
Mission to Planet Earth	. 1	646.5	South Dakota	2	2.2
Space flight	. 4	2,032.8	Tennessee	8	844.9
Space science	. 1	783.7	Texas	22	910.6
National Science Foundation		173.4	Utah	7	75.2
Nuclear Regulatory Commission	. 1	16.0	Vermont	2	3.8
Smithsonian Institution		17.5	Virginia		3,964.4
Tennessee Valley Authority		27.3	Washington		617.9
, , , , , , , , , , , , , , , , , , , ,			West Virginia	9	228.0
			Wisconsin		42.0
			Wyoming		4.7
			Washington, D.C.		487.3
			Puerto Rico		15.8

DEA = Drug Enforcement Administration; IRS = Internal Revenue Service

NOTES: Data for the Department of Defense and the National Aeronautics and Space Administration are from their FY 1994 operating budgets; data for the Department of Education are from its FY 1996 operating budget.

^aData for the Food and Drug Administration exclude product testing activities.

^bThe Agricultural Research Service has R&D laboratories in Argentina, France, and Panama. The Navy has medical labs in Egypt and Indonesia. SOURCE: U.S. General Accounting Office, *Federal R&D Laboratories*, GAO/RCED/NSIAD-96-78R (Washington, DC: 1996).

Appendix table 4-33. Federal R&D obligations to FFRDCs, by administering sector and selected agency: FYs 1987-97 (Millions of current dollars)

	All agencies	Defense	Energy	NASA	All other agencies
	agencies		Lileigy	IVAOA	agencies
		Total			
987	5,580	1,462	3,410	476	233
988	5,891	1,541	3,572	560	217
989	6,075	1,386	3,728	633	328
990	6,425	1,494	3,895	622	415
991	6,451	1,396	3,948	738	369
992	6,718	1,537	3,996	793	392
993	5,871	1,239	3,521	688	424
994	5,322	856	3,310	778	378
995	5,610	823	3,296	1,048	443
996 (est.)	5,255	749	3,131	907	468
997 (est.)	5,214	721	3,201	808	485
	FFRDC:	s administered by i	ndustrv		
87	1,860	325	1,475	0	61
988	1,911	316	1,536	0	60
989	2,056	309	1,588	0	160
990	2,327	419	1,718	0	190
991	2,168	316	1,690	0	162
992	2,117	335	1,607	0	175
993	1,451	202	1,094	0	156
994	1,294	116	1,011	0	167
95	1,204	93	936	0	175
996 (est.)	1,231	76	905	0	250
997 (est.)	1,340	155	933	0	252
997 (est.)	1,340	100	933	<u> </u>	252
	FFRDCs adminis	stered by universiti	es and colleges		
987	3,210	737	1,839	475	158
988	3,474	829	1,945	560	141
989	3,497	686	2,033	630	148
990	3,466	658	2,020	619	168
991	3,604	637	2,072	736	159
992	3,856	668	2,227	791	169
993	3,667	545	2,205	685	232
994	3,293	275	2,077	771	170
995	3,574	262	2,057	1,044	212
996 (est.)	3,302	223	2,002	903	174
997 (est.)	3,231	203	2,035	804	189
	FFRDCs adminis	tered by other non	profit institutions		
987	511	400	96	1	14
988	506	397	91	1	16
989	522	391	107	3	20
990	632	416	157	2	57
991	679	442	186	2	49
992	746	534	163	2	47
993	753	492	222	2	37
994	736	466	222	7	41
995	831	468	303	4	57
996 (est.)	721	449		4	44
` ,			224		44 45
1997 (est.)	644	363	233	4	4

FFRDCs = federally funded research and development centers; NASA = National Aeronautics and Space Administration

SOURCES: National Science Foundation, Science Resources Studies Division (NSF/SRS), Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1996); NSF/SRS, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997); and unpublished tabulations.

See text table 4-7.

Appendix table 4-34.

Federal obligations for R&D to federally funded research and development centers, by individual FFRDC and agency: FY 1995 (Thousands of dollars)

FFRDC	Total	Commerce	Defense	Energy	HHS	NASA	NSF	agencies
TOTAL, ALL FFRDCs	5,609,641	129	823,106	3,295,890	186,057	1,047,684	141,476	115,299
FFRDCs administered by industrial firms	1,203,899	0	93,468	935,637	142,164	0	10	32,620
Energy Technology Engineering Center	11,783	0	48	11,526	0	0	0	209
Idaho National Engineering Laboratory	77,745	0	1,578	63,753	0	0	0	12,414
NCI Frederick Cancer R&D Center	141,707	0	72	0	141,635	0	0	0
Oak Ridge National Laboratory	288,332	0	9,086	267,663	529	0	10	11,044
Sandia National Laboratories	654,472	0	82,659	562,860	0	0	0	8,953
Savannah River Technology Center	29,860	0	25	29,835	0	0	0	0
FFRDCs administered by universities & colleges	3,574,349	129	261,520	2,057,324	24,478	1,043,913	140,883	46,102
Ames Laboratory	29,815	0	30	25,930	0	0	0	3,855
Argonne National Laboratory	252,879	4	1,841	246,877	0	240	0	3,917
Brookhaven National Laboratory	216,094	20	2,696	199,269	2,806	353	1,448	9,472
Ernest Orlando Lawrence Berkeley National Laboratory	170,870	75	879	156,754	12,343	703	116	0
Fermi National Accelerator Laboratory	170,917	0	0	170,917	0	0	0	0
Jet Propulsion Laboratory	1,056,916	0	25,778	0	0	1,031,078	09	0
Lawrence Livermore National Laboratory	500,622	0	32,857	461,840	3,192	1,016	2	1,715
Lincoln Laboratory	158,648	0	150,206	0	0	343	0	8,099
Los Alamos National Laboratory	540,637	0	24,781	489,485	5,537	812	1162	18,860
National Astronomy & Ionosphere Center	7,669	0	0	0	0	0	2,669	0
National Center for Atmospheric Research	79,483	0	462	0	0	7,449	71,572	0
National Optical Astronomy Observatories	29,099	0	0	0	0	0	29,099	0
National Radio Astronomy Observatory	29,960	0	0	0	363	0	29,597	0
Oak Ridge Institute for Science & Education	16,747	0	25	14,330	237	1,919	52	184
Princeton Plasma Physics Laboratory	115,284	0	0	115,178	0	0	106	0
Software Engineering Institute	21,965	0	21,965	0	0	0	0	0
Stanford Linear Accelerator Center	117,713	0	0	117,713	0	0	0	0
Thomas Jefferson National Accelerator Facility	59,031	0	0	59,031	0	0	0	0
FFRDCs administered by other nonprofit institutions	831,393	0	468,118	302,929	19,415	3,771	583	36,577
Aerospace FFRDC	137,495	0	136,552	0	0	738	202	0
Arroyo Center	2,621	0	2,621	0	0	0	0	0
C3I Federally Funded Research & Development Center	192,993	0	190,330	0	0	2,549	114	0
Center for Advanced Aviation System Development	15,961	0	7,073	0	0	0	0	8,888
Center for Naval Analyses	44,143	0	44,056	0	0	0	87	0
Center for Nuclear Waste Regulatory Analyses	5,795	0	0	0	0	0	0	5,795
Critical Technologies Institute	009	0	009	0	0	0	0	0
Inhalation Toxicology Research Institution	7,417	0	0	6,648	692	0	0	0
Institute for Defense Analyses Studies & Analyses FFRDC	56,215	0	56,038	0	0	0	177	0
Logistics Management Institute	2,271	0	1,871	0	0	200	0	200

Appendix table 4-34.

Federal obligations for R&D to federally funded research and development centers, by individual FFRDC and agency: FY 1995 (Thousands of dollars)

FFRDC	Total	Commerce	Defense	Energy	SHH	NASA	NSF	Other agencies
National Defense Research Institute	14,326	0	2,633	0	11,558	135	0	0
National Renewable Energy Laboratory	102,278	0	0	102,278	0	0	0	0
Pacific Northwest National Laboratory	208,529	0	2,944	194,003	7,088	0	0	4,494
Project Air Force	24,149	0	24,000	0	0	149	0	0
Tax Systems Modernization Institute	17,200	0	0	0	0	0	0	17,200

SOURCE: National Science Foundation, Science Resources Studies Division, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997). FFRDC = federally funded research and development center; HHS = Department of Health and Human Services; NASA = National Aeronautics and Space Administration; NSF = National Science Foundation

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Appendix table 4-35.

Federal obligations for R&D to federally funded research and development centers, by individual FFRDC: FYs 1987-95 (Thousands of dollars)

FFRDC	1987	1988	1989	1990	1991	1992	1993	1994	1995
TOTAL, ALL FFRDCs	5,580,231	5,890,825	6,075,331	6,398,286	6,451,491	6,610,876	5,871,234	5,321,939	5,609,641
FFRDCs administered by industrial firms	1,859,963	1,911,314	2,056,329	2,326,808	2,168,256	2,009,767	1,451,325	1,293,494	1,203,899
Bettis Atomic Power Laboratory ^a	383,460	350,859	358,097	331,506	334,486	318,395	0	0	0
Energy Technology Engineering Center	20,284	14,746	10,470	9,364	16,270	13,231	14,288	1,010	11,783
Hanford Engineering Development Laboratory ^a	98,289	94,020	93,045	98,048	13,722	9,765	0	0	0
Idaho National Engineering Laboratory	117,743	104,112	120,067	173,209	175,143	134,220	68,452	85,853	77,745
Knolls Atomic Power Laboratory ^a	245,258	291,615	311,642	290,513	317,818	361,461	0	0	0
NCI Frederick Cancer R&D Center	6,854	13,600	110,285	143,961	114,380	16,430	107,112	127,181	141,707
Oak Ridge National Laboratory	236,553	249,570	277,707	422,146	292,433	291,305	319,357	288,824	288,332
Sandia National Laboratories	703,904	732,811	670,551	704,925	736,940	801,367	883,304	730,311	654,472
Savannah River Technology Center	47,618	59,981	104,465	153,136	167,064	63,593	58,812	60,315	29,860
FFRDCs administered by universities & colleges	3,209,624	3,473,924	3,497,050	3,449,838	3,603,818	3,855,467	3,666,498	3,292,933	3,574,349
Ames Laboratory	15,812	17,657	17,588	19,527	26,906	24,808	26,992	27,796	29,815
Argonne National Laboratory	187,063	200,871	211,732	249,181	254,080	256,434	273,859	258,533	252,879
Brookhaven National Laboratory	180,802	195,112	214,837	202,992	222,755	217,953	212,759	218,792	216,094
Ernest Orlando Lawrence Berkeley									
National Laboratory	120,459	122,226	142,641	240,242	146,705	160,124	169,294	174,136	170,870
Fermi National Accelerator Laboratory	136,650	145,475	160,462	157,947	158,883	166,220	168,117	168,684	170,917
Institute for Advanced Technology	0	0	0	1,579	2,548	7,078	13,873	0	0
Jet Propulsion Laboratory	483,964	678,811	771,362	608,709	797,629	963,504	741,535	785,880	1,056,916
Lawrence Livermore National Laboratory	877,401	905,311	779,275	652,888	815,470	802,136	705,261	526,388	500,622
Lincoln Laboratory	261,262	223,643	207,930	210,322	199,104	190,266	291,842	136,058	158,648
Los Alamos National Laboratory	645,046	665,812	655,138	627,304	603,461	623,077	637,417	552,389	540,637
National Astronomy & Ionosphere Center	5,814	6,752	6,187	7,337	6,051	7,347	7,766	10,035	7,669
National Center for Atmospheric Research	42,165	40,824	46,560	46,200	49,315	54,564	55,897	59,527	79,483
National Optical Astronomy Observatories	23,958	23,005	24,028	24,413	25,740	28,510	27,545	28,271	29,099
National Radio Astronomy Observatory	16,375	17,300	18,457	28,516	30,636	35,315	29,215	29,218	29,960
Oak Ridge Institute for Science & Education	11,561	13,539	12,600	26,550	15,942	21,716	16,993	24,082	16,747
Princeton Plasma Physics Laboratory	89,938	89,717	90,066	89,487	87,713	109,719	106,097	102,109	115,284
Software Engineering Institute	13,992	18,937	17,870	33,674	22,396	29,025	21,688	25,247	21,965
Stanford Linear Accelerator Center	90,312	99,707	109,500	115,491	115,118	134,074	131,568	121,429	117,713
Thomas Jefferson National Accelerator Facility	7,050	9,225	10,817	17,479	23,366	23,597	28,780	44,359	59,031
FFRDCs administered by other nonprofit institutions	510,644	505,587	521,952	621,640	679,417	745,642	753,411	735,512	831,393
Aerospace FFRDC	97,792	71,232	67,832	115,547	97,701	223,686	153,102	144,900	137,495
Arroyo Center	0	0	0	356	22,789	18,131	15,140	1,765	2,621
C3I Federal Contract Research Center	192,651	234,259	227,152	163,641	183,220	156,896	188,068	189,967	192,993
Center for Advanced Aviation System Development	0	0	0	21,863	17,813	35,410	36,300	17,498	15,961
Center for Naval Analyses	34,316	34,990	34,694	38,046	48,121	42,493	45,464	46,733	44,143
Center for Nuclear Waste Regulatory Analyses	0	0	1,625	2,635	3,287	3,040	4,983	5,234	5,795
Critical Technologies Institute	0	0	0	0	0	0	009	0	0
Inhalation Toxicology Research Institute	0	0	8,210	7,704	7,524	7,516	8,052	7,341	7,417

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Appendix table 4-35.

Federal obligations for R&D to federally funded research and development centers, by individual FFRDC: FYs 1987-95 (Thousands of dollars)

FFRDC	1987	1988	1989	1990	1991	1992	1993	1994	1995
Institute for Defense Analyses Studies & Analyses FFRDC	27,691	33,326	41,124	54,828	44,229	49,378	48,575	46,731	56,215
Logistics Management Institute	1,608	2,013	1,145	36,328	3,341	2,045	3,928	3,122	2,271
National Defense Research Institute	17,152	15,819	21,427	7,375	25,849	23,634	8,396	17,833	14,326
National Renewable Energy Research Laboratory ^b	52,401	47,632	50,889	60,849	72,558	77,847	111,304	81,948	102,278
Pacific Northwest Laboratories	66,734	66,316	67,622	112,373	130,585	105,566	125,659	148,440	208,529
Project Air Force	20,299	0	232	92	22,400	0	1,685	24,000	24,149
Tax Systems Modernization Institute	0	0	0	0	0	0	2,155	2,155	17,200

FFRDC = federally funded research and development center

*The Department of Energy decertified Bettis Atomic Power Laboratory, Hanford Engineering Development Laboratory, and Knolls Atomic Power Laboratory as FFRDCs in October/November 1992.

^bIn September 1991, the name was changed from Solar Energy Research Institute.

SOURCES: National Science Resources Studies Division, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997); and unpublished tabulations.

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Appendix table 4-36. Advanced Technology Program awards: 1990-96

	1990	1991	1992	1993	1994	1995	1996	Total
Number of awards	11	28	21	29	88	103	8	288
Single applicants	6	18	18	24	50	62	6	184
Joint ventures	5	10	3	5	38	41	2	104
Total participants ^a	35	83	32	50	211	318	12	741
Resubmittals	NA	3	7	6	4	17	2	39
Funding (\$ millions)	96	202	97	118	640	827	37	2,019
ATP share	46	93	48	60	309	414	19	989
To joint ventures	38	65	19	19	216	304	9	670
To single applicants	8	28	29	41	93	110	10	319
Industry share	52	109	49	58	331	413	18	1,030
From joint ventures	45	83	19	20	233	340	10	750
From single applicants	7	26	30	38	98	73	8	280

ATP = Advanced Technology Program

NOTE: Funding of each award is the total in a period of two to six years.

SOURCE: U.S. Department of Commerce, Advanced Technology Program, unpublished tabulations.

See figure 4-17.

^aTotal participants include single applicants, joint venture leads, and joint venture participants. This category excludes subcontractors, informal collaborators with joint ventures, and collaborators and strategic partners of single applicants.

Appendix table 4-37. Small Business Innovation Research awards, by award type and agency: FYs 1983-95 (Millions of current dollars)

Award type and agency	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Cumu- lative 1983-95
Total ^a By type	45	108	199	298	351	389	432	461	483	508	869	718	865	5,555
Phase I awards	45	48	69	66	110	102	108	118	128	128	154	220	232	1,561
Phase II awards	0	09	130	199	241	285	322	342	336	371	491	474	602	3,853
By agency														
Defense	20	45	78	151	194	208	233	241	241	242	385	354	414	2,806
Health and Human Services	7	23	45	22	29	73	26	84	93	102	126	133	181	1,070
National Aeronautics and Space														
Administration	2	13	59	36	32	47	25	62	69	26	98	116	118	744
Energy	2	16	56	59	28	30	33	33	33	43	20	53	70	461
National Science Foundation	2	7	9	15	17	17	19	20	22	23	59	34	42	260
Agriculture	-	7	က	4	4	4	4	4	2	9	7	7	6	09
Transportation	*	2	က	4	က	က	4	4	9	က	4	7	10	53
Environmental Protection Agency	*	-	2	က	က	က	က	က	4	4	2	2	7	43
Education	*	-	-	7	2	7	2	7	က	2	က	က	က	56
Nuclear Regulatory Commission	*	-	-	-	-	-	-	-	0	-	7	-	7	13
Commerce	0	0	0	-	5	-	-	-	-	2	7	4	80	23
Interior	*	-	*	0	0	0	0	0	0	0	0	0	0	-

^{* =} less than \$500,000

*Totals are Small Business Innovation Research award obligations that include award modifications. The details by award type and agency do not necessarily contain subsequent year revisions and may not sum to totals.

SOURCE: U.S. Small Business Administration, Small Business Innovation Development Act (Washington, DC: annual series).

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Appendix table 4-38. **Budgetary impact and company claims of the federal research and experimentation tax credit: FYs 1981-97** (Millions of dollars)

	Credits claimed by U.S. firms (current \$) ^a	Outlay equivalent cost of credit (current \$) ^b	Total federal R&D outlays	Ratio of credit outlays to R&D (%)	Credits claimed by U.S. firms (constant \$) ^a	Outlay equivalent cost of credit (constant \$) ^b
1981	639	205	32,459	0.63	981	315
1982	839	640	34,391	1.86	1,203	917
1983	1,278	1,010	36,659	2.76	1,751	1,384
1984	1,589	3,360	39,691	8.47	2,097	4,434
1985	1,628	2,430	44,171	5.50	2,076	3,099
1986	1,292	2,295	50,609	4.53	1,603	2,847
1987	1,053	2,715	51,612	5.26	1,270	3,274
1988	1,277	1,240	54,739	2.27	1,488	1,445
1989	1,341	1,590	59,450	2.67	1,499	1,778
1990	1,547	1,625	62,135	2.62	1,660	1,744
1991	1,585	1,070	61,130	1.75	1,631	1,101
1992	1,578	1,850	62,934	2.94	1,578	1,850
1993	NA	1,900	65,241	2.91	NA	1,851
1994	NA	2,110	66,159	3.19	NA	2,009
1995	NA	1,820	66,375	2.74	NA	1,691
1996	NA	1,245	66,877	1.86	NA	1,131
1997	NA	1,055	67,692	1.56	NA	934

NA = not available

NOTES: Tax expenditure estimates are prepared by the U.S. Treasury Department, based on the income tax law enacted as of December 31 of the year for which the expenditures are reported. Expenditures for the years 1996-97 are estimated based on the income tax law enacted as of December 31, 1996. See appendix table 4-1 for GDP implicit price deflators used to convert current dollars to constant 1992 dollars.

b"Outlay equivalent" estimates are comparable to taxable outlay figures reported in the budget. This allows for a comparison of the resource cost of the tax credit with the cost of direct federal R&D expenditure support.

SOURCES: U.S. Office of Management and Budget, *Budget of the United States Government* (Washington, DC: U.S. Government Printing Office, annual series); and U.S. Internal Revenue Service, as reported in Office of Technology Assessment, *The Effectiveness of Research and Experimentation Tax Credits*, OTA-8P-ITC-174 (Washington, DC: U.S. Government Printing Office, 1995).

See figure 4-30.

^aThe value of credits actually received by U.S. firms is less than the amounts claimed.

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Appendix table 4-39. Federal R&D funding, by budget function: FYs 1980, 1985, and 1990-98

Function	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
			Millions	Millions of current dollars	dollars						
Total	29,739	49,887	63,781	65,898	68,398	69,884	68,331	68,791	69,049	70,988	71,602
National defense	14,946	33,698	39,925	39,328	40,083	41,249	37,764	37,204	37,801	39,030	38,726
Nondefense	14,793	16,189	23,856	26,570	28,315	28,635	30,567	31,587	31,249	31,958	32,876
Health	3,694	5,418	8,308	9,226	10,055	10,280	10,993	11,407	11,867	12,693	12,998
Space research and technology	2,738	2,725	5,765	6,511	6,744	6,988	7,414	7,916	7,844	7,795	8,004
General science	1,233	1,862	2,410	2,635	2,659	2,691	2,712	2,794	2,846	2,962	3,086
Energy	3,603	2,389	2,726	2,953	3,153	2,677	2,873	2,844	2,521	2,259	2,229
Natural resources and environment	666	1,059	1,386	1,582	1,688	1,802	1,865	1,988	1,802	1,842	1,902
Transportation	887	1,030	1,045	1,231	1,523	1,703	1,888	1,833	1,795	1,827	1,939
Agriculture	282	836	950	1,052	1,155	1,152	1,193	1,194	1,176	1,185	1,196
Education, training, employment,											
and social services	468	220	374	433	365	348	373	369	331	370	411
International affairs	125	210	375	378	371	382	254	287	252	190	246
Veterans' benefits and services	126	193	216	219	245	250	265	257	259	267	239
Commerce and housing credit	101	114	140	178	192	220	380	525	432	435	498
Community and regional development	119	20	29	88	92	22	89	70	20	54	46
Administration of justice	45	47	44	51	51	49	46	29	26	29	70
Income security	47	21	33	30	37	36	45	43	16	10	10
General government	22	17	17	4	4	-	0	-	2	2	2
			Millions of	constant 1992 dollars	92 dollars						
Total	50,150	63,631	68,435	67,796	68,398	68,113	65,077	63,932	62,716	62,877	61,726
National defense	25,204	42,982	42,838	40,461	40,083	40,204	35,966	34,576	34,333	34,570	33,384
Nondefense	24,946	20,649	25,597	27,335	28,315	27,909	29,111	29,356	28,382	28,306	28,341
Health	6,229	6,911	8,914	9,492	10,055	10,019	10,470	10,601	10,778	11,243	11,205
Space research and technology	4,617	3,476	6,186	6,699	6,744	6,811	7,061	7,357	7,124	6,904	006'9
General science	2,079	2,375	2,586	2,711	2,659	2,623	2,583	2,597	2,585	2,624	2,660
Energy	9/0/9	3,047	2,925	3,038	3,153	2,609	2,736	2,643	2,290	2,001	1,922
Natural resources and environment	1,685	1,351	1,487	1,628	1,688	1,756	1,776	1,848	1,637	1,632	1,640
Transportation	1,496	1,314	1,121	1,266	1,523	1,660	1,798	1,704	1,630	1,618	1,672
Agriculture	286	1,066	1,019	1,082	1,155	1,123	1,136	1,110	1,068	1,050	1,031
Education, training, employment,											
and social services	789	281	401	445	365	339	355	343	301	328	354
International affairs	211	268	402	389	371	372	242	267	229	168	212
Veterans' benefits and services	212	246	232	225	245	244	252	239	235	236	206
Commerce and housing credit	170	145	150	183	192	214	362	488	392	385	429
Community and regional development	201	64	72	91	92	26	9	9	45	48	40
Administration of justice	9/	09	47	52	51	48	44	22	51	29	09
Income security	29	27	35	31	37	35	43	40	15	6	6
General government	37	22	18	4	4	-	0	-	7	7	7
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NOTES: Data for 1980-96 are actual budget authority. Data for 1997 and 1998 are preliminary based on the FY 1998 budget. See appendix table 4-1 for GDP implicit price deflaters used to convert current dollars to constant 1992 dollars.

SOURCE: National Science Foundation, Science Resources Studies Division, Federal R&D Funding by Budget Function: Fiscal Years 1996-98 (Arlington, VA: forthcoming).

See figure 4-28.

Appendix table 4-40. Federal basic research funding, by budget function: FYs 1980, 1985, and 1990-98

Function	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
			Millions	Millions of current dollars	dollars						
Total	4,716	7,810	11,288	12,405	12,973	13,440	13,552	13,772	14,443	14,853	15,296
Health	1,761	3,243	4,661	5,021	5,506	5,700	5,889	6,068	6,395	6,826	7,015
General science	1,152	1,779	2,306	2,526	2,532	2,553	2,542	2,622	2,662	2,773	2,886
Space research and technology	482	498	1,389	1,479	1,499	1,588	1,796	1,614	1,685	1,557	1,517
National defense	552	856	964	1,188	1,147	1,323	1,174	1,181	1,165	1,133	1,191
Energy	200	428	761	878	921	917	921	930	1,182	1,219	1,313
Agriculture	246	406	456	486	528	553	292	292	547	545	563
Natural resources and environment	136	206	336	389	383	376	224	187	147	149	157
Transportation	79	255	242	246	266	238	220	389	456	445	429
Education, training, employment,											
and social services	61	98	106	115	118	121	145	153	140	139	146
Commerce and housing credit	15	23	31	39	35	34	38	35	37	39	40
Veterans' benefits and services	4	15	16	16	16	16	16	16	13	14	14
Administration of justice	6	4	6	9	2	2	5	о	12	12	24
Community and regional development	80	9	က	10	1	10	o	က	0	0	0
General government	I	4	က	0	0	0	0	0	0	0	0
International affairs	0	4	4	9	9	∞	9	0	2	2	-
Income security	-	0	0	0	0	0	0	0	0	0	0
			Millions of	constant 1992 dollars	92 dollars ^a						
Total	7,953	9,966	12,111	12,762	12,973	13,101	12,907	12,799	13,118	13,156	13,186
Health	2,970	4,136	5,001	5,166	5,506	5,556	5,609	5,639	5,808	6,046	6,047
General science	1,943	2,269	2,474	2,599	2,532	2,488	2,421	2,437	2,418	2,456	2,488
Space research and technology	813	635	1,490	1,522	1,499	1,548	1,710	1,500	1,530	1,379	1,308
National defense	931	1,092	1,034	1,222	1,147	1,289	1,118	1,098	1,058	1,004	1,027
Energy	337	546	817	903	921	894	877	864	1,074	1,080	1,132
Agriculture	415	518	489	200	528	539	540	525	497	483	485
Natural resources and environment	229	263	361	400	383	366	213	174	134	132	135
Transportation	133	325	260	253	266	232	210	362	414	394	370
Education, training, employment,											
and social services	103	110	114	118	118	118	138	142	127	123	126
Commerce and housing credit	25	29	33	40	35	33	36	33	34	35	34
Veterans' benefits and services	24	19	17	16	16	16	15	15	12	12	12
Administration of justice	15	2	10	9	2	2	2	80	Ξ	Ξ	21
Community and regional development	13	80	က	10	1	10	တ	က	0	0	0
General government	I	2	က	0	0	0	0	0	0	0	0
International affairs	0	2	4	9	9	80	9	0	2	7	-
Income security	7	0	0	0	0	0	0	0	0	0	0
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NOTE: Data for 1980-96 are actual budget authority. Data for 1997 and 1998 are preliminary based on the FY 1998 budget.

^aSee appendix table 4-1 for GDP implicit price deflaters used to convert current dollars to constant 1992 dollars.

SOURCE: National Science Foundation, Science Resources Studies Division, Federal R&D Funding by Budget Function: Fiscal Years 1996-98 (Arlington, VA: forthcoming).

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Appendix table 4-41. **Distribution of government R&D budget appropriations, by socioeconomic objective: Most recent year** (Percentages)

Objective	United States (1996)	Japan (1996)	Germany (1995)	France (1996)	United Kingdom (1995)	Italy (1995)	Canada (1995)
Total (millions of U.S. \$) ^a	69,049	15,068	15,285	13,255	8,184	6,478	3,264
Agriculture, forestry,							
and fishing	2.4	3.4	2.6	3.6	4.6	2.7	13.8
Industrial development	0.6	3.8	13.2	4.8	9.3	8.8	10.4
Energy	3.7	19.8	3.5	4.7	0.9	3.1	8.2
Infrastructure	2.7	2.0	1.6	0.5	1.8	0.5	5.1
Transport and							
telecommunications	2.6	1.7	0.5	NA	0.3	NA	3.9
Urban and rural planning	0.1	0.3	1.1	NA	1.5	NA	1.2
Environmental protection	0.7	0.6	3.5	2.0	2.1	2.4	2.5
Health	17.6	2.8	3.1	5.2	7.7	8.8	8.9
Social development							
and services	1.0	1.1	2.4	0.9	2.5	2.8	3.7
Earth and atmosphere	1.2	1.3	2.4	0.8	2.2	1.4	1.6
Advancement of knowledge	4.1	52.1	52.8	35.2	24.8	52.8	33.4
Advancement of research	4.1	11.1	14.6	19.2	6.1	8.0	14.1
General university funds	_	41.0	38.2	16.0	18.7	44.8	19.4
Civil space	11.4	7.0	5.1	10.9	2.9	8.7	7.5
Defense	54.7	6.2	9.1	29.0	40.8	4.7	4.8
Not elsewhere classified	0.0	0.0	0.7	2.5	0.4	3.3	0.0

NA = not separately available but included in subtotal; - = the United States does not have an equivalent to general university funds

NOTES: Percentages may not add to 100 because of rounding. U.S. data are based on budget authority. Because of general university funds and slight differences in accounting practices, the distribution of government budgets among socioeconomic objectives may not completely reflect the actual distribution of government-funded research in particular objectives. Japanese data are based on science and technology budget data, which include items other than R&D. Such items are a small proportion of the budget; therefore, the data may still be used as an approximate indicator of relative government emphasis on R&D by objective.

^aConversions of foreign currencies to U.S. dollars are calculated with purchasing power parity exchange rates. (See appendix table 4-2.)

SOURCES: National Science Foundation, Science Resources Studies Division, Federal R&D Funding by Budget Function: Fiscal Years 1996-98 (Arlington, VA: forthcoming); and Organisation for Economic Co-operation and Development, Main Science and Technology Indicators database (Paris: August 1997).

See figure 4-26.

Appendix table 4-42. International R&D expenditures and R&D as a percentage of GDP: 1981-97

	United States	Japan	Germany ^a	France	United Kingdom	Italy	Canada
	Total R&I) expenditures	in billions of co	nstant 1992 U.	S. dollars ^b		
1981	109.2	35.0	23.8	16.8	17.6	7.0	5.3
1982	114.9	37.6	24.5	18.0	NA	7.2	5.7
983	122.6	40.5	25.0	18.5	17.0	7.7	5.8
984	134.3	43.6	25.7	19.6	NA	8.4	6.3
985	145.5	48.4	28.3	20.4	18.5	9.6	6.8
986	148.8	49.1	29.2	20.7	19.4	9.9	7.2
987	151.4	52.5	31.3	21.5	19.7	10.7	7.3
988	155.0	56.7	32.4	22.5	20.3	11.4	7.4
989	157.8	62.1	33.8	24.0	20.9	12.0	7.6
990	162.0	67.2	34.1	25.4	21.3	12.8	8.0
991	165.0	68.6	36.5	25.7	19.6	13.2	8.1
992	164.9	69.6	37.2	26.5	20.7	13.6	8.4
993	161.0	67.4	35.6	25.8	20.7	12.4	8.9
994	160.5	66.4	35.5	25.2	20.7	11.8	9.2
995	170.1	70.6	35.4	25.2	19.9	11.8	9.3
996	175.6	NA	33.1	NA	NA	11.6	9.3
997	182.2	NA	NA	NA	NA	NA	NA
		R&D expend	itures as a perce	ntage of GDP			
981	2.32	2.13	2.43	1.97	2.37	0.88	1.25
982	2.49	2.22	2.52	2.06	NA	0.91	1.40
983	2.55	2.35	2.52	2.11	2.19	0.95	1.37
984	2.61	2.43	2.51	2.21	NA	1.01	1.41
985	2.74	2.58	2.72	2.25	2.23	1.13	1.45
986	2.71	2.55	2.73	2.23	2.25	1.13	1.49
987	2.68	2.62	2.88	2.27	2.19	1.19	1.44
988	2.64	2.66	2.86	2.28	2.14	1.22	1.39
989	2.60	2.77	2.87	2.33	2.15	1.24	1.39
990	2.64	2.85	2.75	2.41	2.18	1.30	1.47
991	2.71	2.82	2.61	2.41	2.11	1.32	1.52
992	2.64	2.76	2.48	2.42	2.13	1.31	1.57
993	2.52	2.68	2.43	2.45	2.15	1.26	1.63
994	2.43	2.64	2.33	2.38	2.11	1.16	1.62
995	2.52	2.78	2.28	2.34	2.05	1.14	1.61
996	2.55	NA	2.26	NA	NA	1.13	1.59
997	2.59	NA	NA	NA	NA	NA	NA

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Appendix table 4-42. International R&D expenditures and R&D as a percentage of GDP: 1981-97

	United States	Japan	Germanya	France	United Kingdom	Italy	Canada
To	tal R&D exp	enditures in billi	ons of constant	1992 units of r	national currenc	ey ^c	
1981	109.2	6,678.0	52.2	110.0	11.0	10,469.1	6.7
1982	114.9	7,171.3	53.7	117.5	NA	10,841.8	7.3
1983	122.6	7,757.3	54.6	121.3	10.8	11,548.6	7.4
1984	134.3	8,335.2	55.9	128.2	NA	12,576.3	8.0
1985	145.5	9,249.3	61.7	133.4	11.6	14,388.2	8.7
1986	148.8	9,406.9	63.4	135.4	12.2	14,887.0	9.2
1987	151.4	10,055.2	67.8	140.9	12.4	16,103.5	9.3
1988	155.0	10,825.8	70.0	147.2	12.8	17,124.5	9.4
1989	157.8	11,832.1	72.8	156.4	13.1	17,954.5	9.6
1990	162.0	12,820.3	73.7	165.9	13.4	19,161.9	10.2
1991	165.0	13,146.5	78.6	166.7	12.7	19,760.0	10.3
1992	164.9	13,001.1	76.4	169.4	12.7	19,660.7	10.7
1993	161.0	12,655.4	73.9	169.6	13.1	18,698.4	11.4
1994	160.5	12,510.7	72.8	168.5	13.4	17,608.1	11.8
1995	170.1	13,303.9	72.6	169.4	13.3	17,787.7	12.0
1996	175.6	NA	72.7	NA	NA	17,776.9	12.0

NA = not available

SOURCES: National Science Foundation, Science Resources Studies Division, *National Patterns of R&D Resources: 1997 Data Update*, <<http://www.nsf.gov/sbe/srs/natpat97/start.htm>>; and Organisation for Economic Co-operation and Development, Main Science and Technology Indicators database (Paris: August 1997).

See figures 4-18, 4-19, 4-20, and 4-21.

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Appendix table 4-43. **R&D** as a percentage of GDP in selected former communist countries: 1990-95 (Percentages)

	Russian Federation	Czech Republic	Hungary	Poland
1990	2.03	NA	NA	NA
1991	1.43	2.12	1.07	NA
1992	0.74	1.83	1.05	NA
1993	0.77	1.35	0.98	NA
1994	0.84	1.25	0.89	0.82
1995	0.73	1.15	0.75	0.74

NA = not available

SOURCES: Organisation for Economic Co-operation and Development, Main Science and Technology Indicators database (Paris: August 1997); and Centre for Science Research and Statistics, *Russian Science and Technology at a Glance: 1996* (Moscow: 1997).

See figure 4-22.

^aGerman data before 1991 are for West Germany only.

^bConversions of foreign currencies to U.S. dollars are calculated with purchasing power parity exchange rates. Constant 1992 dollars are based on U.S. GDP implicit price deflators. (See appendix tables 4-1 and 4-2.)

^cConstant foreign currencies are based on deflation with each countries' GDP implicit price deflators.

Appendix table 4-44. International nondefense R&D expenditures and R&D as a percentage of GDP: 1981-97

	United States	Japan	Germany ^a	France	United Kingdom	Italy	Canada
Tota	al nondefens	se R&D expend	ditures in billions	of constant 1	992 U.S. dollars ^b		
981	81.4	34.8	23.0	13.4	13.7	6.8	5.1
982	82.6	37.4	23.7	14.5	NA	7.1	5.6
983	86.3	40.3	24.0	15.2	13.1	7.4	5.6
984	93.9	43.3	24.7	16.1	NA	8.0	6.1
985	100.4	48.0	27.1	16.9	14.6	9.1	6.6
986	101.9	48.8	28.0	17.0	15.6	9.4	7.0
987	103.3	52.1	29.9	17.5	16.2	10.3	7.0
988	107.8	56.2	31.0	18.3	17.1	10.8	7.1
989	113.8	61.6	32.4	19.7	17.6	11.4	7.3
990	120.9	66.6	32.6	20.5	18.0	12.4	7.7
991	127.8	67.9	35.0	21.1	16.6	12.7	7.9
992	129.4	68.9	35.8	22.4	17.8	13.1	NA
993	126.3	66.5	34.5	22.0	17.8	11.9	8.7
994	128.6	65.6	34.3	21.7	18.0	11.3	NA
995	138.3	69.7	34.2	NA	17.2	11.5	9.1
996	144.4	NA	NA	NA	NA	NA	NA
997	151.7	NA NA	NA NA	NA	NA NA	NA NA	NA NA
997			xpenditures as a			INA	INA
201	1.73	2.12	2.34	1.57	1.84	0.85	1.21
981							
982	1.79	2.21	2.44	1.66	NA 1.00	0.89	1.36
983	1.80	2.34	2.43	1.74	1.69	0.93	1.33
984	1.83	2.41	2.42	1.82	NA 1.70	0.97	1.36
985	1.89	2.56	2.60	1.87	1.76	1.07	1.41
986	1.86	2.53	2.61	1.84	1.82	1.08	1.44
987	1.83	2.60	2.75	1.85	1.79	1.15	1.39
988	1.84	2.63	2.74	1.85	1.80	1.15	1.34
989	1.88	2.75	2.75	1.92	1.81	1.18	1.34
990	1.97	2.83	2.62	1.95	1.84	1.26	1.43
991	2.10	2.79	2.51	1.98	1.79	1.27	1.49
992	2.07	2.73	2.39	2.04	1.83	1.27	NA
993	1.98	2.65	2.35	2.10	1.85	1.21	1.59
994	1.95	2.60	2.25	2.05	1.84	1.11	NA
995	2.05	2.74	2.20	NA	1.78	1.11	1.58
996	2.10	NA	NA	NA	NA	NA	NA
997	2.15	NA	NA	NA	NA	NA	NA

NA = not available

SOURCES: National Science Foundation, Science Resources Studies Division, *National Patterns of R&D Resources: 1997 Data Update*, <<http://www.nsf.gov/sbe/srs/natpat97/start.htm>>; and Organisation for Economic Co-operation and Development, Main Science and Technology Indicators database (Paris: August 1997).

See figures 4-19 and 4-21.

^aGerman data before 1991 are for West Germany only.

^bConversions of foreign currencies to U.S. dollars are calculated with purchasing power parity exchange rates. Constant 1992 dollars are based on U.S. GDP implicit price deflators. (See appendix tables 4-1 and 4-2.)

Appendix table 4-45. International R&D expenditures, by performing sector and source of funds: Mid-1990s

			So	urce of R&D fur	ıds		Percent
				Higher	Private		distribution
R&D performer	Total	Industry	Government	education	nonprofit	Abroad	performers
			Billions of yen				
Japan, 1995 total	13,358	9,644	2,741	874	83	14	100.0
Industry	9,396	9,223	149	_	10	13	70.3
Government	1,391	10	1,379	1	-	-	10.4
Higher education	1,932	45	1,012	872	3	_	14.5
•	640	366	201	1	70	_ 1	4.8
Private nonprofit				•		•	4.0
Percent distribution, sources	100.0	72.2	20.5	6.5	0.6	0.1	
			ons of deutsch n				
Germany, 1996 total	79,860	48,800	29,430	0	260	1,370	100.0
Industry	53,100	47,250	4,750	_	100	1,000	66.5
Government	11,500	400	10,770	-	160	170	14.4
Higher education	15,260	1150	13,910	_	_	200	19.1
Private nonprofit	_	_	_	_	_	_	0.0
Percent distribution, sources	100.0	61.1	36.9	0.0	0.3	1.7	
			Millions of franc	S			
France, 1994 total	175,563	85,462	73,049	996	1,503	14,553	100.0
Industry	108,568	82,266	14,062	21	33	12,186	61.8
Government	36,217	1,916	32,675	56	27	1,543	20.6
Higher education	28,407	896	26,046	716	104	646	16.2
Private nonprofit	2,369	384	26,040	203	1,339	178	1.3
·	•				•		1.3
Percent distribution, sources	100.0	48.7	41.6	0.6	0.9	8.3	
			Millions of pound				
United Kingdom, 1995 total	14,328	6,877	4,777	117	505	2,052	100.0
Industry	9,379	6,478	1,122	_	_	1,780	65.5
Government	2,076	228	1,752	3	34	59	14.5
Higher education	2,695	167	1,823	114	380	211	18.8
Private nonprofit	177	5	79	_	90	3	1.2
Percent distribution, sources	100.0	48.0	33.3	0.8	3.5	14.3	
			Billions of lire				
Italy, 1996 total	20,985	10,380	9,692	0	0	913	100.0
Industry	12,113	10,035	1,427	_	_	651	57.7
Government	4,174	85	3,946	_	_	142	19.9
Higher education	4,698	260	4,318	_	_	120	22.4
Private nonprofit	-,050	_	-,010	_	_	-	0.0
Percent distribution, sources	100.0	49.5	46.2	0.0	0.0	4.4	
			ns of Canadian o				
Canada, 1996 total	12,939	6,029	4,538	296	343	1,357	100.0
Industry	8,143	5,670	777		-	1,321	62.9
Government	1,841	27	1,809	_	_	5	14.2
				206	262	18	
Higher education	2,775	296	1,901	296	263		21.4
Private nonprofit	180	36	51	_	80	13	1.4
Percent distribution, sources	100.0	46.6	35.1	2.3	2.7	10.5	

^{- =} assumed negligible or no data available

See figure 4-23.

SOURCE: Organisation for Economic Co-operation and Development, unpublished tabulations.

Appendix table 4-46. **R&D** expenditures in the United States, by performing sector and domestic and foreign source of funds: 1980, 1987, and 1995
(Millions of U.S. dollars)

			Soi	urce of R&D fun	ds		Percent
R&D performer	Total	Industry	Government	Higher education	Private nonprofit	Foreign	distribution, performers
Total 1980 expenditures	63,076	29,409	29,857	1,382	911	1,517	100.0
Industry	44,505	28,959	14,029	_	_	1,517	70.6
Government	7,831	-	7,831	_	_	_	12.4
Higher education	8,565	250	6,522	1,382	411	_	13.6
Other nonprofit	2,175	200	1,475	-	500	_	3.4
Percent distribution, sources	100.0	46.6	47.3	2.2	1.4	2.4	
Total 1987 expenditures	125,840	58,173	58,253	3,259	1,658	4,497	100.0
Industry	92,155	56,906	30,752	_	_	4,497	73.2
Government	13,588	_	13,588	_	_	-	10.8
Higher education	16,768	811	11,843	3,259	855	-	13.3
Other nonprofit	3,329	456	2,070	_	803	_	2.6
Percent distribution, sources	100.0	46.2	46.3	2.6	1.3	3.6	
Total 1995 expenditures	183,013	96,026	63,147	5,739	3,129	14,972	100.0
Industry	132,103	93,680	23,451	_	_	14,972	72.2
Government	17,231	_	17,231	_	_	_	9.4
Higher education	27,708	1,516	18,839	5,739	1,613	_	15.1
Other nonprofit	5,971	830	3,626	_	1,516	_	3.3
Percent distribution, sources	100.0	52.5	34.5	3.1	1.7	8.2	

^{- =} assumed negligible or no data available

NOTE: Foreign sources represent funding from companies in the United States with foreign ownership of 50 percent or more.

SOURCES: National Science Foundation, Science Resources Studies Division, *National Patterns of R&D Resources: 1997 Data Update, <<ha>http://www.nsf.gov/sbe/srs/natpat97/start.htm>>; and U.S. Bureau of Economic Analysis, unpublished tabulations.</hd>*

See figure 4-23.

Appendix table 4-47. Discrepancy between federal R&D support as reported by performers and by federal agencies: 1980-96 (Billions of dollars)

		All performers		Ind	dustrial perform	ers
	Performer- reported	Agency- reported	Difference	Performer- reported	Agency- reported	Difference
1980	29.9	29.8	0.0	12.8	13.0	-0.2
1981	33.7	33.1	0.6	15.0	14.9	0.1
1982	37.1	36.4	0.7	17.1	17.2	-0.1
1983	41.4	38.7	2.7	19.1	17.0	2.1
1984	46.3	42.2	4.1	21.7	18.6	3.0
1985	52.5	48.4	4.1	25.3	21.7	3.6
1986	54.5	51.4	3.1	26.0	24.2	1.8
1987	58.3	55.3	3.0	28.8	26.8	2.0
1988	59.9	56.8	3.2	28.2	26.7	1.5
1989	60.3	61.4	-1.1	26.4	28.5	-2.2
1990	61.5	63.6	-2.1	25.8	29.4	-3.6
1991	60.6	61.3	-0.7	24.1	26.4	-2.3
1992	60.7	65.6	-4.9	22.4	29.7	-7.4
1993	60.4	67.3	-7.0	20.8	30.2	-9.4
1994	60.7	67.3	-6.6	20.3	30.5	-10.2
1995	63.1	68.8	-5.6	21.2	30.5	-9.3
1996	62.8	69.1	-6.3	20.9	31.3	-10.3

NOTES: Performer-reported data are expenditures, and agency-reported data are obligations. Data for 1996 are preliminary. The differences in the two series are derived from unrounded data, not shown in the table.

SOURCES: National Science Foundation, Science Resources Studies Division (NSF/SRS), National Patterns of R&D Resources: 1997 Data Update, <<http://www.nsf.gov/sbe/srs/natpat97/start.htm>>; and NSF/SRS, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997).

See figure 4-27.

Appendix table 4-48. Distribution of strategic technology alliances between and within economic blocs, by technology: 1980-96

		Totala			Biotechnology		Inforr	Information technologies	ogies		New materials	
	Total	Inter- region	Intra- region	Total	Inter- region	Intra- region	Total	Inter- region	Intra- region	Total	Inter- region	Intra- region
				Num	Number of international alliances	tional allian	seo					
1980	136	09	92	58	22	36	99	33	33	12	5	7
1981	156	99	06	46	13	33	92	46	49	15	7	80
1982	200	108	92	71	27	44	107	89	39	22	13	6
1983	210	106	104	45	20	25	133	69	64	32	17	15
1984	296	134	162	73	27	46	200	26	103	23	10	13
1985	386	160	226	132	54	78	201	84	117	53	22	31
1986	405	151	254	120	37	83	212	91	121	73	23	20
1987	404	164	240	126	26	70	212	83	129	99	25	41
1988	402	152	250	115	39	9/	217	96	121	48	17	31
1989	355	148	207	78	37	4	233	92	141	44	19	25
1990	287	122	165	34	17	17	222	98	136	31	19	12
1991	264	119	145	34	17	17	212	92	117	18	7	=
1992	355	149	206	82	42	40	240	93	147	33	14	19
1993	399	165	234	117	20	29	226	92	134	99	23	33
1994	489	203	286	174	83	91	277	105	172	38	15	23
1995	282	244	343	199	86	101	340	122	218	48	24	24
1996	483	201	282	168	92	73	280	92	185	35	=======================================	24
			Percen	Percentage share, by interregional and intraregional distribution	y interregion	al and intrare	egional distr	lbution				
1980	100	44	56	100	38	62	100	50	50	100	42	58
1981	100	42	58	100	28	72	100	48	52	100	47	53
1982	100	54	46	100	38	62	100	64	36	100	29	41
1983	100	20	20	100	44	56	100	52	48	100	53	47
1984	100	45	22	100	37	63	100	49	52	100	43	22
1985	100	4	29	100	41	29	100	42	58	100	42	58
1986	100	37	63	100	31	69	100	43	22	100	32	89
1987	100	41	29	100	44	26	100	39	61	100	38	62
1988	100	38	62	100	34	99	100	44	26	100	32	65
1989	100	42	28	100	47	53	100	33	61	100	43	22
1990	100	43	22	100	20	20	100	39	61	100	61	39
1991	100	45	22	100	20	20	100	45	22	100	39	61
1992	100	42	28	100	51	49	100	39	61	100	42	58
1993	100	41	29	100	43	22	100	41	29	100	41	29
1994	100	42	28	100	48	52	100	38	62	100	39	61
1995	100	42	28	100	49	51	100	36	64	100	20	20
1996	100	42	28	100	25	43	100	34	99	100	31	69
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Appendix table 4-48. Distribution of strategic technology alliances between and within economic blocs, by technology: 1980-96

		Totala			Biotechnology		Inform	Information technologies	ogies		New materials	
				Nun	Number of interregional alliances	gional allian	ces					
	Europe- Japan	Europe- U.S.	Japan- U.S.	Europe- Japan	Europe- U.S.	Japan- U.S.	Europe- Japan	Europe- U.S.	Japan- U.S.	Europe- Japan	Europe- U.S.	Japan- U.S.
1980	5	40	15	0	15	7	5	20	80	0	5	0
1981	10	30	26	-	4	ω	7	23	16	2	က	2
1982	15	54	39	7	7	4	o	37	22	4	9	က
1983	18	37	51	2	12	9	12	19	38	4	9	7
1984	19	09	55	0	18	6	41	41	42	2	-	4
1985	26	82	52	7	30	17	13	44	27	9	∞	œ
1986	26	78	47	-	22	4	19	46	26	9	10	7
1987	16	92	53	2	37	41	9	48	29	2	10	10
1988	15	86	39	-	30	80	=	62	23	က	9	80
1989	18	98	44	7	21	6	80	56	28	ဇ	o	7
1990	22	99	34	က	12	2	15	42	29	4	12	က
1991	15	53	51	-	14	2	12	37	46	2	2	ဇ
1992	17	88	43	က	33	9	12	52	29	2	4	80
1993	16	104	45	2	38	10	10	48	34	4	18	-
1994	18	145	40	2	71	7	12	63	30	-	1	က
1995	23	167	54	7	84	7	12	69	4	4	41	9
1996	16	135	20	9	92	13	6	20	36	-	0	-
				Num	Number of intraregional alliances	gional allian	ces					
	Europe	Japan	U.S.	Europe	Japan	U.S.	Europe	Japan	U.S.	Europe	Japan	U.S.
1980	29	2	42	10	-	25	13	4	16	9	0	-
1981	30	12	48	80	2	23	18	80	23	4	2	2
1982	27	8	22	9	2	36	17	4	18	4	7	က
1983	33	20	51	o	2	41	17	15	32	7	က	2
1984	59	15	88	14	4	28	40	7	26	2	4	4
1985	105	35	86	38	7	33	09	10	47	7	18	9
1986	78	28	118	15	16	52	52	15	54	7	27	12
1987	69	38	133	18	6	43	46	7	92	2	22	4
1988	98	23	141	31	2	40	48	7	99	7	7	13
1989	74	Ξ	122	16	7	23	45	7	88	13	7	10
1990	34	10	121	2	0	12	25	6	102	4	-	7
1991	29	10	106	2	0	15	24	တ	84	က	-	7
1992	41	10	155	10	-	29	25	о	113	9	0	13
1993	32	7	192	10	2	22	4	4	116	1	-	21
1994	39	12	235	25	-	65	6	6	154	2	7	16
1995	54	80	281	27	-	73	22	4	192	2	က	16
1996	43	=	228	20	0	53	18	∞	159	2	က	16
-	4 - 4 - 5 - 1 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4	3-1	1000		1							

^aIncludes all agreements reported for biotechnology, information technologies, and new materials.

SOURCE: J. Hagedoorn, Maastricht Economic Research Institute on Innovation and Technology, Cooperative Agreements and Technology Indicators database, unpublished tabulations.

See figures 4-31 and 4-32.

Appendix table 4-49. **Proportion of industrial R&D expenditures financed from foreign sources, by selected country: 1980-96** (Percentages)

	Canada	France	Germany ^a	Italy	Japan	United Kingdom	United States
1980	NA	NA	NA	NA	NA	NA	3.4
1981	7.4	7.0	1.2	4.3	0.1	8.7	NA
1982	10.7	4.8	1.3	4.7	0.1	NA	NA
1983	16.6	4.6	1.4	4.3	0.1	6.8	NA
1984	17.1	6.5	1.5	6.2	0.1	NA	NA
1985	14.3	6.9	1.4	6.1	0.1	11.1	NA
1986	13.6	8.0	1.4	7.3	0.1	12.2	NA
1987	16.8	8.7	1.5	6.9	0.1	12.0	4.9
1988	18.0	9.2	2.1	6.6	0.1	12.0	5.7
1989	16.7	10.9	2.7	6.5	0.1	13.4	6.6
1990	17.4	11.1	2.7	7.3	0.1	15.5	7.8
1991	18.0	11.4	2.6	8.6	0.1	16.0	7.8
1992	NA	12.0	2.5	5.4	0.1	15.0	9.0
1993	17.2	11.3	1.9	5.9	0.1	15.4	9.6
1994	17.0	11.2	2.0	8.1	0.1	16.0	10.6
1995	NA	NA	1.9	5.4	0.1	19.0	11.3
1996	17.0	NA	1.9	5.4	NA	NA	NA

NA = not available

NOTE: There are no data on foreign sources of U.S. industrial R&D performance. The figures shown here to approximate such foreign involvement are the estimated percentages of U.S. industrial performance undertaken by majority-owned (that is, 50 percent or more) nonbank U.S. affiliates of foreign companies.

SOURCES: U.S. Bureau of Economic Analysis, unpublished tabulations; and Organisation for Economic Co-operation and Development, Main Science and Technology Indicators database (Paris: August 1997).

See figure 4-24.

^aGerman data before 1991 are for West Germany only.

Appendix table 4-50. Company-financed R&D performed abroad by U.S. companies and their foreign subsidiaries, by industry: 1985-95

Industry	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
			Millions o	Millions of current U.S. dollars	. dollars						
Total Food kindred and tobacco products	3,650	4,624	5,226	6,208	6,706	7,952	9,147	10,063	9,565	9,395	13,052
Chemicals and allied products	843	1,071	1,243	1,548	1,532	2,007	2,401	2,676	2,833	2,456	4,194
Industrial and other chemicals	444	579	625	855	609	720	1,009	1,045	1,318	917	1,632
Drugs and medicines	339	492	618	693	923	1,287	1,392	1,631	1,561	1,539	2,562
Petroleum refining and extraction	47	40	47	29	47	92	107	119	104	111	92
Stone, clay, and glass products	۵	Ω	Ω	Ω	Ω	29	38	41	38	27	31
Primary metals	۵	Ω	18	23	24	26	20	18	12	15	26
Fabricated metal products	21	26	40	Ω	۵	92	86	109	119	125	111
Machinery	689	951	1,233	1,326	1,432	1,451	1,476	1,439	340	308	501
Electrical equipment	591	Ω	432	591	573	770	651	268	525	495	872
Transportation equipment	1,025	Ω	Ω	1,750	1,916	2,055	2,402	Ω	Ω	Ω	Ω
Professional and scientific instruments	169	212	317	404	474	611	929	685	751	006	988
Nonmanufacturing industries	18	27	64	146	256	415	778	832	1,770	1,500	2,206
		2	Millions of constant 1992	nstant 1992	U.S. dollars	83					
Total	4,646	5,738	6,292	7,210	7,474	8,492	6,399	10,063	9,321	8,951	12,134
Food, kindred, and tobacco products	92	86	45	31	47	44	89	88	109	111	132
Chemicals and allied products	1,073	1,329	1,496	1,798	1,707	2,143	2,467	2,676	2,761	2,340	3,899
Industrial and other chemicals	265	718	752	993	629	692	1,037	1,045	1,284	874	1,517
Drugs and medicines	208	610	744	805	1,029	1,374	1,430	1,631	1,521	1,466	2,382
Petroleum refining and extraction	09	20	25	69	52	81	110	119	101	106	7.
Stone, clay, and glass products	۵	Δ	۵	۵	Ω	63	39	4	37	26	29
Primary metals	۵	Δ	22	27	27	28	21	18	12	1	24
Fabricated metal products	27	32	48	Ω	۵	101	88	109	116	119	103
Machinery	877	1,180	1,484	1,540	1,596	1,550	1,517	1,439	331	293	466
Electrical equipment	752	Δ	520	989	629	822	699	568	512	472	811
Transportation equipment	1,305	Δ	۵	2,032	2,135	2,195	2,468	۵	Ω	Δ	Δ
Professional and scientific instruments	215	263	382	469	528	653	674	685	732	857	919
Nonmanufacturing industries	23	34	77	170	285	443	299	835	1,725	1,429	2,051

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Appendix table 4-50. Company-financed R&D performed abroad by U.S. companies and their foreign subsidiaries, by industry: 1985-95

Industry	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
			Percentag	e of domest	c funding						
Total	6.4	7.7	8.5	9.3	9.1	9.7	10.1	10.7	10.1	6.7	12.0
Food, kindred, and tobacco products	9.9	5.4	3.1	2.3	3.4	3.3	5.2	6.3	8.3	7.9	9.1
Chemicals and allied products	10.1	12.4	13.2	14.3	12.8	15.2	16.6	17.7	17.0	14.8	24.2
Industrial and other chemicals	9.2	11.6	11.7	14.4	9.5	6.6	13.5	14.6	17.5	13.2	22.9
Drugs and medicines	11.5	13.5	15.1	14.1	16.7	21.8	20.0	20.6	17.1	16.0	25.1
Petroleum refining and extraction	2.1	2.0	2.5	3.0	2.2	3.3	4.3	5.2	4.9	5.7	4.3
Stone, clay, and glass products	Ω	Ω	Ω	Ω	۵	11.0	8.4	8.6	7.2	4.9	7.0
Primary metals	Ω	Ω	2.5	3.7	3.6	3.6	2.8	3.5	1.9	2.2	4.5
Fabricated metal products	2.7	3.3	6.3	۵	۵	12.9	11.5	15.1	12.7	14.4	11.8
Machinery	6.4	8.9	11.7	11.1	10.7	10.7	10.8	10.4	4.1	3.8	5.2
Electrical equipment	6.4	۵	4.1	5.9	0.9	8.3	7.3	0.9	4.5	3.7	5.1
Transportation equipment	8.5	Ω	Ω	12.6	13.1	14.4	16.2	Ω	Ω	Ω	۵
Professional and scientific instruments	3.7	4.5	6.4	7.6	8.3	9.7	9.6	9.4	10.0	11.2	11.6
Nonmanufacturing industries	0.4	9.0	1.2	2.0	2.5	2.5	3.4	3.6	7.2	6.3	8.0

D = withheld to avoid disclosing operations of individual companies

*See appendix table 4-1 for GDP implicit price deflators used to convert current dollars to constant 1992 dollars.

SOURCE: National Science Foundation, Science Resources Studies Division, Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming).

See figure 4-35.

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Appendix table 4-51. Expenditures for R&D performance for majority-owned foreign affiliates of U.S. parent companies, by region/country: 1982 and 1989-94 (Millions of U.S. dollars)

Region/country	1982	1989	1990	1991	1992	1993	1994
Total	3,647	7,048	10,187	9,396	11,084	10,951	11,482
Canada	545	914	1,159	1,039	1,006	1,025	852
Europe	2,591	5,178	7,952	7,143	8,024	7,533	8,255
Belgium	181	317	388	383	458	455	523
France	263	545	882	907	1,021	941	1,249
Germany	893	1,496	2,561	2,504	2,726	2,567	3,216
Ireland	31	134	539	573	664	664	464
Italy	136	294	476	327	326	304	389
Netherlands	101	360	459	478	482	393	260
Spain	36	115	103	100	323	320	D
Sweden	29	33	130	83	84	48	67
Switzerland	51	67	76	91	101	109	145
United Kingdom	805	1,673	2,221	1,606	1,737	1,634	1,706
Other European countries	65	144	117	91	102	98	D
Asia and Pacific	294	760	846	916	1,719	1,964	1,817
Japan	104	488	512	596	664	881	1,088
Australia	120	181	197	144	173	175	225
Singapore Other Asian and	D	25	54	87	360	312	243
Pacific countries	D	66	83	89	522	596	261
Latin America and other							
Western Hemisphere	179	153	201	253	291	383	502
Brazil	96	90	113	149	172	220	253
Mexico	38	37	53	64	76	D	189
Other Latin America	45	26	35	40	43	D	60
Middle East	11	32	16	30	25	28	38
Africa	26	11	13	15	19	18	19
South Africa	23	9	10	12	16	14	14
Other African countries	3	2	3	3	3	4	5

D = withheld to avoid disclosing operations of individual companies

NOTES: The data include foreign direct investments of nonbank U.S. affiliates conducted by and for the foreign affiliates. The data exclude expenditures for R&D conducted for others under a contract. Benchmark survey statistics are reported for 1982, 1989, and 1994. Data are preliminary for 1994. Expenditures reported here differ from the data in appendix table 4-50.

SOURCE: U.S. Bureau of Economic Analysis, U.S. Direct Investment Abroad: Operations of U.S. Parent Companies and Their Foreign Affiliates (Washington, DC: U.S. Government Printing Office, annual series).

See figures 4-33, 4-34, and 4-36.

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Appendix table 4-52. Foreign R&D expenditures in the United States, by industry and region/country: 1980-95 (Millions of current U.S. dollars)

Industry and region/country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total	1,946	3,110	3,744	4,164	4,738	5,240	5,804	6,521	7,834	9,465	11,522	11,872	13,864	14,199	15,566	17,666
						Expendi	Expenditures by industry	dustry								
Petroleum	۵	253	255	310	366	388	380	311	364	387	520	438	586	428	407	387
Manufacturing		2,645	3,133	3,553	4,058	4,478	5,011	5,573	6,903	8,398	9,868	10,177	11,383	11,842	12,970	14,743
Food and kindred products	19	35	39	4	43	51	24	28	106	187	192	195	245	266	294	301
Chemicals and allied																
products	834	1,580	1,870	2,037	2,349	2,627	2,782	3,220	3,719	4,371	5,243	5,755	Ω	6,580	7,003	8,326
Industrial chemicals	454	1,085	1,329	1,397	1,620	1,836	1,657	1,899	2,126	2,284	2,498	2,391	Ω	1,906	1,993	2,540
Other chemicals	146	179	120	181	200	228	167	230	276	252	372	427	490	442	204	231
Drugs and medicines	234	316	371	429	529	263	928	1,091	1,318	1,835	2,373	2,937	3,211	4,232	4,506	5,255
Primary metal industries	24	7	26	29	99	102	26	9	102	155	166	189	173	201	170	172
Fabricated metal products Machinery, except	51	50	58	85	24	64	92	29	106	508	152	145	Ω	172	178	176
electrical	189	284	297	350	355	342	286	476	692	1,070	1,190	1,094	1,098	1,019	954	1,089
Office and companing	Š	Š	<u> </u>	Š	Ž	2	Š	07.0	107		70	700	17.4	700	47	0
macnines	¥ :	≨ :	¥ :	¥ ;	¥ :	₹ :	₹ ;	370	497	279	794	88/	7.74	624	478 -1-	225
Other	Z Z	₹	Z Z	Z	Z Z	₹	A A	100	195	448	396	306	324	395	475	537
Electrical equipment	318	382	202	613	799	977	1,366	1,105	1,389	1,371	1,817	1,647	1,953	2,168	2,613	2,770
Transportation equipment	101	136	150	95	92	83	124	92	225	265	193	207	Ω	266	375	478
Protessional and	;	í	ļ		!	;		į				į	•	i	į	;
scientific instruments	35	25	47	42	45	28	112	279	242	366	420	472	Ω	281	671	682
Nonmanufacturing			į	;	į	į		;	!	;						
industries	۵	212	356	301	314	374	413	637	295	089	1,134	1,257	1,895	1,929	2,189	2,536
Services	37	43	41	21	09	24	22	243	69	108	384	328	744	932	966	922
Other	٥	169	315	250	254	320	336	394	498	572	750	899	1,151	266	1,193	1,614
						=xpenditure	es by region/country	n/country								
Canada	135	777	1,032		1,405	1,550	1,542	1,666	1,804	1,758	1,944	2,060	2,113	2,159	2,332	1,396
Europe	1,544	1,936	2,229	2,324	2,632	2,918	3,450	3,881	4,754	6,022	7,520	7,785	8,993	9,362	10,313	13,370
United Kingdom	312	405	520	229	664	748	764	833	1,171	1,645	1,889	2,046	2,177	2,211	2,499	2,419
Germany	380	436	529	591	602	671	851	1,139	1,242	1,503	1,764	1,720	2,100	2,209	2,425	3,976
France	146	204	232	215	261	166	352	366	435	572	812	953	1,204	1,235	1,449	1,644
Netherlands	299	373	397	387	432	514	217	542	618	703	784	663	969	269	736	838
Switzerland	338	416	447	463	246	625	744	292	362	1,195	1,669	1,849	2,064	2,423	2,444	3,088
Sweden	36	23	24	62	63	116	141	128	166	214	281	237	308	200	289	807
Other European countries	33	49	20	47	49	78	8	108	160	190	321	317	444	387	471	298
Japan	88	142	141	171	210	267	292	307	571	822	1,307	1,353	1,709	1,801	1,790	1,867
Latin America	Ω	Ω	Ω	401	423	427	427	391	352	400	386	397	280	239	637	280
All other countries	٥	۵	٥	26	89	78	93	276	353	463	365	277	469	338	494	753

D = withheld to avoid disclosing operations of individual companies; NA = not available

NOTES: The data include foreign direct investments of nonbank U.S. affiliates with 10 percent or more foreign ownership and exclude expenditures for R&D conducted for others under a contract.

SOURCE: U.S. Bureau of Economic Analysis, Foreign Direct Investment in the United States: Operations of U.S. Affiliates of Foreign Companies (Washington, DC: U.S. Government Printing Office, annual series).

Appendix table 4-53.

R&D expenditures in the United States by majority-owned nonbank U.S. affiliates of foreign companies, by industry of affiliate and country of ultimate beneficial owner: 1980 and 1987-95 (Millions of current U.S. dollars)

Industry and region/country	1980	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total	1,517	4,497	5,485	6,720	8,511	9,127	10,745	11,262	12,671	14,972
			Expenditures by industry	by industry						
Petroleum	175	283	339	378	Ο	۵	551	420	400	382
Manufacturing	1,245	3,809	4,773	5,915	7,282	7,839	9,056	9,560	10,855	12,913
Food and kindred products	19	58	105	185	189	190	240	260	283	294
Chemicals and allied products	733	۵	Ω	Ω	3,832	4,266	4,692	5,167	5,654	7,298
Industrial and other chemicals	501	۵	Ω	۵	1,465	Ω	Ω	۵	1,429	2,919
Drugs and medicines	232	1,075	1,293	1,806	2,367	Ω	Ω	۵	4,225	4,379
Rubber products	∞	20	86	117	155	150	305	216	210	211
Stone, clay, and glass products	10	32	61	62	114	102	113	106	151	157
Primary metal industries	Ω	38	37	75	69	82	79	83	77	71
Fabricated metal products	Ω	62	100	201	138	132	136	155	165	162
Machinery, except electrical	92	۵	446	556	645	602	609	529	551	989
Computer and office equipment	28	۵	285	295	380	341	328	247	203	248
Other	65	62	161	260	264	261	281	282	348	388
Electrical and electronic equipment	285	۵	1,114	1,078	1,533	1,562	1,880	2,061	2,549	2,704
Household audio & video, and comm. equip	99	255	777	721	971	626	1,129	1,133	1,345	1,515
Electronic components and other	219	۵	337	357	562	603	752	928	1,204	1,189
Transportation equipment	10	۵	Δ	Δ	106	159	203	231	331	434
Professional and scientific instruments	28	254	210	295	333	411	556	524	218	593
Nonmanufacturing industries	26	405	373	427	Δ	Ω	1,138	1,282	1,416	1,677
Services	2	29	42	77	۵	Ω	211	420	455	430
Wholesale trade	69	312	300	297	571	682	803	745	839	1,113
Motor vehicles and equipment	Δ	98	29	71	283	277	252	220	182	179
Electrical goods	2	71	107	Δ	145	224	220	157	236	336
Other	23	34	31	53	Ω	۵	124	117	122	134

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Appendix table 4-53.

R&D expenditures in the United States by majority-owned nonbank U.S. affiliates of foreign companies, by industry of affiliate and country of ultimate beneficial owner: 1980 and 1987-95

(Millions of current U.S. dollars)

Industry and region/country	1980	1987	1988	1989	1990	1991	1992	1993	1994	1995
		Exp	Expenditures by	by region/country	try					
Canada	113	D	Q	Q	Q	Q	Q	Q	Q	1,350
Europe	1,217	3,458	4,241	5,414	6,762	7,275	8,325	8,628	9,487	11,609
France	39	332	402	510	992	913	1,230	1,190	1,383	1,572
Germany	281	824	963	1,216	1,435	1,596	1,855	2,003	2,147	3,663
Italy	Ω	Ω	73	93	151	143	91	132	157	180
Netherlands	Δ	540	615	069	757	642	685	674	719	816
Sweden	Δ	124	160	205	271	225	322	180	263	۵
Switzerland	329	Ω	Ω	1,060	1,455	1,637	1,873	2,117	2,127	2,471
United Kingdom	247	790	1,085	1,568	1,809	1,987	2,090	2,139	2,428	2,315
Other European countries	16	47	Δ	72	118	132	179	193	263	۵
Asia and Pacific	Ω	179	345	412	962	834	1,080	1,232	1,397	1,646
Japan	Ω	133	282	369	200	741	938	1,112	1,200	1,281
Other	Δ	46	63	43	87	93	142	120	197	365
Latin America & other Western Hemisphere	155	329	302	352	314	330	534	Δ	610	274
Middle East	2	14	o	10	6	6	20	38	62	71
Africa	Δ	Ω	Δ	Δ	Ω	Δ	4	2	2	۵

D = withheld to avoid disclosing operations of individual companies

NOTES: The data include foreign direct investments of nonbank U.S. affiliates with 50 percent or more foreign ownership. These R&D expenditures are a subset of total foreign R&D expenditures reported in appendix table 4-52. The data exclude expenditures for R&D conducted for others under a contract.

SOURCE: U.S. Bureau of Economic Analysis, unpublished tabulations.

See figures 4-33, 4-34, and 4-37.

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Appendix table 4-54. Support for R&D and R&D plant from state government sources: 1995

	Support for R&D and R&D plant	5	Dollars	5	Share state spending	5
	(thousand \$)	Ranking	per capita	Ranking	(percent)	Ranking
Total states	2,514,169		9.59		0.35	
Alabama	230	50	0.05	50	0.00	50
Alaska	5,167	42	8.56	27	0.11	39
Arizona	68,627	12	16.27	10	0.68	6
Arkansas	2,142	43	0.86	44	0.03	44
California	248,756	1	7.87	29	0.29	27
Colorado	24,135	24	6.44	33	0.30	24
Connecticut	6,986	40	2.13	41	0.06	41
Delaware	7,240	39	10.10	18	0.22	32
Florida	245,154	2	17.31	7	0.63	8
Georgia	183,526	4	25.49	4	1.02	3
Hawaii	35,406	23	29.83	2	0.57	9
Idaho	14,304	29	12.30	12	0.52	12
Illinois	105,513	7	8.92	24	0.40	17
Indiana	23,838	25	4.11	37	0.20	34
lowa	49,240	17	17.33	6	0.54	10
Kansas	80,907	10	31.54	1	1.09	2
Kentucky	5,462	41	1.42	42	0.05	42
Louisiana	12,338	32	2.84	40	0.08	40
Maine	12,140	34	9.78	19	0.32	23
Maryland	48,983	18	9.72	21	0.34	21
Massachusetts	21,803	27	3.59	38	0.12	38
Michigan	58,959	15	6.17	34	0.22	31
Minnesota	23,671	26	5.13	36	0.17	35
Mississippi	1,743	44	0.65	47	0.03	47
Missouri	55,448	16	10.41	17	0.48	13
Montana	10,456	37	12.02	13	0.45	15
Nebraska	45,816	19	27.99	3	1.12	1
Nevada	984	45	0.64	48	0.03	46
New Hampshire	10,584	36	9.22	22	0.46	14
New Jersey	69,009	11	8.69	26	0.30	25
New Mexico	12,846.69	31	7.62	30	0.30	33
New York	149,597	6	8.25	28	0.24	30
North Carolina	100,161	8	13.92	11	0.54	11
	•	28	24.46	5		4
North Dakota	15,676 82,989	20 9	7.44	31	0.89 0.28	28
	62,969 9,977	38	3.04	39	0.28	26 37
Oklahoma	•					
Oregon	35,677	22 3	11.36 16.97	15 8	0.33	22 7
Pennsylvania	204,850 746	3 47	0.75	6 46	0.65 0.02	48
Rhode Island						
South Carolina	40,529	21	11.03	16 9	0.38	20
South Dakota	12,324	33 46	16.91		0.74	5 40
Tennessee	755 160 570	46	0.14	49	0.01	49 16
Texas	169,570	5 20	9.06	23	0.43	16
Utah	13,936	30 40	7.14	32 45	0.29	26 45
Vermont	490	49	0.84	45	0.03	45
Virginia	64,707	13	9.78	20	0.38	19
Washington	64,021	14	11.79	14	0.39	18
West Virginia	11,138	35	6.09	35	0.13	36
Wisconsin	45,033	20	8.79	25	0.28	29
Wyoming	557	48	1.16	43	0.03	43

NOTE: These are preliminary tabulations subject to revision and refinement.

SOURCE: Battelle Memorial Institute and the State Science and Technology Institute, Survey of State Research and Development Expenditures: FY 1995 (Columbus, OH: forthcoming).

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Appendix table 4-55.

State R&D expenditures, by performing sector and source of funds: 1995 (Millions of current dollars)

Performing sector:		Total R&D	Federal Govt.		Industry				Universities & colleges	& colleges			U&C FFRDCs	Other nonprofit institutions ^a	Nonprofit FFRDCs
Funding sector:	'	Total R&D	Federal Govt.	Total	Federal Govt. ^b	Industry ^b	Total	Federal Govt.	Nonfederal govt.	Industry	U&C	Nonprofits	Federal Govt.º	Federal Govt.	Federal Govt.
State Ra	Rank														
United States, total	_	183,013	17,343	132,103	23,451	108,652	22,101	13,331	1,655	1,492	4,024	1,599	5,405	2,806	831
Alabama 2	25	1,681	642	989	273	413	335	190	7	59	87	22	0	18	0
Alaska 4	47	163	61	30		Δ	72	37	9	2	24	0	0	-	0
:	24	1,995	178	1,356	620	736	380	210	œ	23	126	12	75	9	0
	44	330	58	181		Δ	88	33	24	∞	20	က	0	က	0
California	-	36,133	1,844	28,710	6,925	21,785	2,594	1,797	107	120	373	198	2,378	362	245
	20	2,603	168	1,865	274	1,591	394	260	22	24	25	35	125	46	2
Connecticut	13	4,311	18	3,906	389	3,517	377	228	19	20	78	32	0	10	0
Delaware 2	28	1,149	15	1,077	12	1,065	53	27	2	4	15	2	0	က	0
	18	3,128	2,106	672	17	656	181	133	-	13	20	15	0	169	0
	12	5,223	554	4,101	1,634	2,467	559	317	41	36	135	29	0	80	0
Geomia	23	2.113	272	1.175	142	1.031	658	305	54	55	222	25	0	œ	0
	38	509	402	14			78	44	27	9 0	4	۳ ا	0	5.	0 0
	35	914	28	827	a 🗅	۵ ۵	29	. 02	; †	<u> </u>	- 16	0 0	0	·	0 0
	7 2	7 487	3 5	5 776	146	5 630	818	468	47	43	195	1 5	771	41	o c
	17	3.163	. 09	2,721	382	2,339	376	197	6	35.	102	8 8	- c	4	o c
	27	1.391	37	966	<u> </u>		323	164	47	6	28	51 - 15	35	- +-) C
	34	764	5 2	569	a 🗅	۵ ۵	181	202	33	2 =	23	. «	j 0	•	0 0
	36	594	9	452	4	448	135	09	10	17	44	2	0	•	0
	41	423	45	61		۵	315	136	72	21	99	19	0	. 2	0
	42	345	4	286	Ω	۵	32	16	2	4	0	-	0	23	0
	c			1	1	1	9	C	1	Ļ	Ĺ	Č	c	9	c
Maryland	י מ	6,519	4,159	1,075	/87	88	1,160	88.00 C C C	٥ ,	ဂ္ဂ ဂ	င္သ	200	o 1	123	N (
Michigan	4 c	9,909	3.10	1,410	4,400	0,808	1,14/	020	ວ 6	, G	38	67	045 C C	26/	<u> </u>
Minnesota 1	۸ b	2,273	30	2,388	2 1 1 1 1 1	2,240	337	4 10 105	4 r	- 6	- 9	73	o c	מ מ	o c
	ر ا	315	133	2,030 66	2 0	1,35,2	113	26.0	8 6	3 0	5 -	ر د	o c	g «	o c
	3 5	2 499	5 7 7	8000	מ מ	1 443	397	243	5 5	. 7	- 6	° ° °	o c	φ	o c
	48	119	34 8	17	5 0	2 0	67	27	- 5	5 6	8 8	3 -	0	<u> </u>	o c
	43	336	23	150		Δ	157	22	45	Ξ	46	က	0	9	0
	40	445	35	322		٥	87	48	9	7	25	-	0	-	0
	35	298	31	472	36	436	93	09	4	4	13	12	0	2	0
New Jersey	2	9,128	344	8,200	197	8,002	443	209	40	26	136	33	126	Ħ	4
	15	3,295	481	1,461	1,380	81	230	157	17	=	33	7	1,109	9	7
New York	ဗ	10,954	117	8,651	1,821	6,831	1,702	1,107	96	86	206	195	281	203	0
	16	3,191	220	2,226	15	2,212	289	432	86	74	62	21	0	29	0
	49	86	25	12	□	۵	09	28	7	က	25	7	0	-	0
	10	5,314	299	4,001	574	3,428	643	375	48	24	107	59	0	72	0
	37	529	45	288	38	249	186	09	20	Ξ	79	17	0	6	0
	30	1,089	26	741	32	902	259	158	30	15	37	21	0	33	0
	œ	6,919	228	5,331	376	4,955	1,140	754	32	120	164	99	35	189	0
Rhode Island	33	968	254	520	Ω	Ω	106	72	က	2	56	5	0	17	0
0 34															

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Appendix table 4-55. State R&D expenditures, by performing sector and source of funds: 1995 (Millions of current dollars)

Performing sector:		Total R&D	Federal Govt.		Industry				Universities	Universities & colleges				Other nonprofit institutions ^a	Nonprofit FFRDCs
Funding sector:		Total R&D	Federal Govt.	Total	Federal Govt. ^b	Industry ^b	Total	Federal Govt.	Nonfederal govt.	I Industry	U&C	Nonprofits	Federal Govt.°	Federal Govt.	Federal Govt.
State	Rank														
South Carolina	31	966	34	739	۵	٥	220	109	18	19	54	19	0	က	0
South Dakota	51	55	13	19	0	19	21	Ξ	7	0	2	-	0	-	0
Tennessee	26	1,402	62	1,003	Ω	Ω	308	192	35	16	45	20	10	20	0
Texas	9	8,385	538	6,211	912	5,298	1,472	748	159	102	297	167	0	163	-
Utah	29	1,144	131	803	178	625	202	141	15	6	28	6	0	∞	0
Vermont	46	308	2	248	Ω	۵	54	33	2	2	10	4	0	-	0
Virginia	14	3,897	1,581	1,577	743	834	447	262	47	46	64	28	74	42	177
Washington	=	5,241	160	4,294	Ω	۵	486	340	14	33	77	15	0	96	205
West Virginia	39	475	140	243	Δ	۵	53	30	7	က	13	4	33	9	0
Wisconsin	22	2,226	40	1,706	33	1,673	473	271	43	17	95	51	0	7	0
Wyoming	20	87	0	25	Δ	۵	40	15	က	2	17	က	0	13	0
Other/unknown		5,805	771	1,772	3,502	8,875	548	320	53	30	114	30	16	248	26

FFRDCs = federally funded research and development centers; U&C = universities and colleges; D = data have been withheld to avoid disclosing information about individual companies

NOTES: Data are based on annual reports by performers, except for the nonprofit sector. Details may not sum to totals because of rounding.

*State data for nonprofit performance using nonfederal funds are not available. For 1995, total nonprofit performance is estimated at \$5,152 million. Industry provided an estimated \$8.30 million to the nonprofit sector, and nonprofit institutions provided an estimated \$1,516 million. These amounts are included in the total R&D "other/unknown" category.

Pederal support for industry R&D includes performance at industry FFRDCs; industry support of industry R&D includes all nonfederal sources.

clncludes total R&D expenditures of FFRDCs administered by academic institutions.

SOURCES: National Science Foundation, Science Resources Studies Division (NSF/SRS), Research and Development in Industry: 1995 (Arlington, VA: 1998, forthcoming); NSF/SRS, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997).

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Appendix table 4-56.

Annual aggregate data on independent research and development: FYs 1963-96 (Millions of current dollars)

		Accep	oted by govern	Accepted by government IR&D program	ıgram	Not accepted	DOD and	R&D obligations ^a	gationsª	Percent of R&D performed by	formed by
	Incurred by industry	Total accepted	DOD	NASA	Not reimbursed	under IR&D program	NASA IR&D reimbursement	DOD to industry	NASA to industry	industry with funding from:b DOD & NASA (1) DOD (ng from: ^b DOD (2)
		1									
1963	439	255	/6L	24	34	184	221	5,1/3	2,307	3.0	3.8
1964	419	272	199	20	23	147	249	4,880	3,369	3.0	4.1
1965	439	300	198	09	42	139	258	4,362	3,853	3.1	4.5
1966	502	357	224	69	9	145	293	4.557	3.928	3,5	4.9
1967	591	439	277	28	104	152	335	5,428	3,798	3.6	5.1
1968	776	579	338	61	180	197	399	5,090	3,382	4.7	9.9
1969	808	653	410	43	200	155	453	5,157	2,899	5.6	8.0
1970	753	297	376	44	177	156	420	4,524	2,521	0.9	8.3
1971	703	267	354	4	172	136	395	4,629	2,077	5.9	7.6
1972	936	725	392	40	293	211	432	5,108	1,960	6.1	7.7
1973	1,164	876	441	40	395	288	481	5,138	1,961	6.8	8.6
1974	1,175	921	467	33	415	254	206	5,173	1,785	7.3	9.0
1975	1,224	1,010	493	40	477	214	533	5,640	1,792	7.2	8.7
1976	1,388	1,061	544	41	476	327	585	6,019	2,042	7.3	9.0
1977	1,560	1,199	298	46	222	361	644	266,9	2,002	7.2	8.5
1978	1,788	1,365	643	49	673	423	692	7,317	2,043	7.4	8.8
1979	2,104	1,517	208	54	755	287	762	7,695	2,270	9.7	9.5
1980	2,373	1,728	812	22	829	645	869	9,022	1,924	7.9	0.6
1981	2,796	2,039	1,056	99	917	757	1,122	10,826	2,096	8.7	8.6
1982	3,654	2,821	1,338	29	1,416	833	1,405	13,795	1,433	9.5	9.7
1983	4,017	2,961	1,601	78	1,282	1,056	1,679	14,541	1,030	10.8	11.0
1984	5,173	3,897	1,884	98	1,927	1,276	1,970	15,967	1,263	11.4	11.8
1985	5,036	3,500	2,099	88	1,313	1,536	2,187	18,944	1,576	10.7	1.1
1986	5,042	3,537	2,198	77	1,262	1,505	2,275	21,502	1,584	6.6	10.2
1987	4,885	3,544	2,186	29	1,291	1,341	2,253	23,934	1,463		9.1
1988	4,825	3,694	2,181	88	1,424	1,131	2,270	23,295	1,962	9.0	9.4
1989	4,866	3,798	2,233	110	1,455	1,068	2,343	24,734	2,426	8.6	0.6
1990	4,910	3,766	2,158	131	1,477	1,144	2,289	24,443	3,285	8.3	8.8
1991	5,099	4,327	2,203	133	1,991	772	2,336	21,034	3,667	9.5	10.5
1992	4,903	4,320	2,117	84	2,119	583	2,201	24,107	3,765	7.9	8.8
1993	3,337	3,085	1,904	151	1,030	252	2,055	23,654	4,112	7.4	8.0
1994	3,068	2,842	1,746	167	929	226	1,913	23,408	4,305	6.9	7.5
1995	2,848	2,720	1,619	167	934	128	1,786	22,553	4,687	9.9	7.2
1996	3,031	2,863	1,768	172	923	168	1,940	24,395	5,258	6.5	7.2

DOD = Department of Defense; IR&D = independent research and development; NASA = National Aeronautics and Space Administration

NOTES: The significant decrease in reported statistics between FYs 1992 and 1993 is primarily due to (1) change in the Federal Acquisition Regulations definition of "major contractor" and (2) change in the Defense Contractors with auditable costs of \$40 million or more; the current threshold is \$70 million or more. The increase in the percentage of IR&D costs accepted is due to an expansion of the activities eligible for reimbursement.

Includes R&D performed by federally funded research and development centers administered by the industrial sector.

*Percentages were calculated as follows: numerator in (1) is total DOD and NASA IR&D reimbursements, and denominator is total DOD and NASA R&D performed by industry, excluding IR&D; numerator in (2) is total DOD IR&D reimbursements, and denominator is DOD R&D performed by industry, excluding IR&D. SOURCES: Defense Contract Audit Agency, Independent Research and Development and Bid and Proposal Costs Incurred by Major Defense Contractors 1976-96 (Washington, DC: annual series); NASA, unpublished tabulations; J. Reppy, "Defense Department Payments for 'Company-Financed' R&D," Research Policy Vol. 6, No. 4 (October 1977); p. 403; National Science Foundation, Science Resources Studies Division (NSF/SRS), Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956-1996, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development, Detailed Historical Tables: Fiscal Years 1956, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development, Development Tables: Fiscal Funds for Research and Development Tables: Fiscal Funds for Research and Development Tables: Fiscal Years 1956, NSF 96-320 (Arlington, VA: 1996); and NSF/SRS, Federal Funds for Research and Development Tables: Fiscal Funds for Research and Funds for Research and Page Funds for Research and Page Funds for Research Funds for Research and Page Funds for Research and Page Funds for Research Funds for Research And Funds for Research Funds for Resea ment: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, NSF 97-327 (Arlington, VA: 1997).

Appendix table 5-1. Total, federally funded, and nonfederally funded academic R&D, by basic research, applied research, and development: 1960-97 (Percentages)

		Total academic R&D	emic R&D		Fede	rally supporte	Federally supported academic R&D	7&D	Nonfe	derally suppo	Nonfederally supported academic R&D	R&D
	Total academic	Basic research	Applied research	Develop- ment	Total academic	Basic research	Applied research	Develop- ment	Total academic	Basic research	Applied research	Develop- ment
1960	100.0	68.8	26.3	4.9	64.2	75.2	20.6	4.2	35.8	57.1	36.7	6.2
1961	100.0	71.7	23.8	4.5	8.99	77.5	18.6	3.9	33.2	59.9	34.3	5.8
1962	100.0	74.2	21.8	4.0	69.2	79.5	17.3	3.3	30.8	62.4	31.9	2.7
1963	100.0	77.1	19.5	3.4	71.2	82.2	15.2	2.6	28.8	64.7	30.0	5.3
1964	100.0	77.9	18.6	3.5	72.4	82.8	14.3	3.0	27.6	65.1	29.9	5.0
1965	100.0	76.5	19.0	4.4	73.2	80.8	15.0	1.4	26.8	64.8	29.9	5.3
1966	100.0	75.9	19.3	4.8	73.4	79.9	15.6	4.6	26.6	65.0	29.6	5.4
1967	100.0	76.3	19.1	4.6	73.2	7.67	15.9	4.4	26.8	67.2	27.7	5.1
1968	100.0	76.8	18.5	4.6	72.5	79.8	15.7	4.5	27.5	69.1	25.9	5.0
1969	100.0	76.9	18.3	4.8	71.2	79.3	15.8	4.9	28.8	71.0	24.4	4.6
1970	100.0	76.7	18.6	4.6	2.69	78.5	16.6	5.0	30.3	72.7	23.4	3.9
1971	100.0	76.7	19.5	3.8	9.89	78.7	17.4	3.9	31.4	72.4	24.0	3.6
1972	100.0	73.9	22.4	3.7	9.89	76.0	20.7	3.3	31.4	69.3	26.3	4.4
1973	100.0	71.2	24.5	4.2	68.0	74.1	22.4	3.5	32.0	65.1	29.1	5.8
1974	100.0	71.0	24.7	4.4	67.2	74.5	22.1	3.4	32.8	63.7	30.0	6.3
1975	100.0	69.5	26.2	4.4	67.2	73.7	22.9	3.4	32.8	6.09	32.9	6.3
1976	100.0	9.89	26.7	4.7	67.2	73.5	22.7	3.8	32.8	28.7	34.9	6.5
1977	100.0	68.5	26.1	5.4	8.99	73.3	21.9	4.7	33.2	58.9	34.4	8.9
1978	100.0	2.79	25.3	7.1	66.4	72.3	20.7	7.0	33.6	58.4	34.4	7.2
1979	100.0	67.2	24.6	8.2	67.2	71.1	20.1	8.7	32.8	59.2	33.8	7.1
1980	100.0	2.99	25.1	8.1	67.4	70.2	21.2	9.8	32.6	59.5	33.2	7.3
1981	100.0	0.79	25.1	6.7	66.3	71.3	20.6	8.1	33.7	58.4	34.1	7.5
1982	100.0	8.99	25.2	8.0	64.6	71.3	20.4	8.3	35.4	58.6	34.0	7.5
1983	100.0	67.1	25.4	7.5	63.2	70.9	21.3	7.7	36.8	60.4	32.5	7.1
1984	100.0	8.99	25.7	7.4	62.9	70.8	21.6	9.2	37.1	60.1	32.8	7.2
1985	100.0	6.79	24.7	7.3	62.3	71.9	20.6	9.2	37.7	61.4	31.6	6.9
1986	100.0	68.7	24.1	7.2	61.2	72.7	19.8	7.5	38.8	62.4	30.8	8.9
1987	100.0	68.3	24.6	7.1	60.5	72.1	20.5	7.4	39.5	62.3	30.9	8.9
1988	100.0	62.9	26.4	7.8	9.09	69.2	22.6	8.2	39.4	8.09	32.2	7.1
1989	100.0	65.4	26.9	7.7	29.8	68.9	23.0	8.1	40.2	60.1	32.7	7.2
1990	100.0	65.5	26.3	8.2	58.9	69.2	21.9	8.9	41.1	60.3	32.6	7.1
1991	100.0	66.1	25.4	8.5	58.4	9.69	20.8	9.6	41.6	61.2	31.8	7.0
1992	100.0	66.5	25.2	8.3	59.2	2.69	21.0	9.5	40.8	61.9	31.2	6.9
1993	100.0	2.99	25.1	8.2	0.09	70.4	20.6	0.6	40.0	61.3	31.7	7.0
1994	100.0	0.79	24.7	8.3	60.2	70.9	20.0		39.8	61.1	31.9	7.0
1995	100.0	0.79	24.8	8.2	60.2	71.1	20.0	8.9	39.8	6.09	32.1	7.0
1996 (est.)	100.0		25.0	8.0	59.9	71.0	20.3		40.1	61.0	32.0	7.0
1997 (est.)	100.0	67.0	24.9	ж. Г.	59.4	0.17	20.1	ა ი:ა	40.6	61.1	31.9	7.0

NOTE: See appendix tables 4-4, 4-5, 4-6, and 4-7 for the data underlying these percentages.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, National Patterns of R&D Resources: 1996, NSF 96-333 (Arlington, VA: 1996); and NSF, unpublished tabulations.

See figure 5-2.

Appendix table 5-2. Support for academic R&D, by sector: FYs 1960-97

				Source of supp	ort	
	Takal	Federal	State/local	la dicata .	Academic	All other
	Total	Government	government	Industry	institutions	sources
		Millions of	f current dollars			
1960	646	405	85	40	64	52
1961	763	500	95	40	70	58
1962	904	613	106	40	79	66
1963	1,081	760	118	41	89	73
964	1,275	917	132	40	103	83
965	1,474	1,073	143	41	124	93
966	1,715	1,261	156	42	148	108
967	1,921	1,409	164	48	181	119
968	2,149	1,572	172	55	218	132
969	2,225	1,600	197	60	223	145
970	2,335	1,647	219	61	243	165
1971	2,500	1,724	255	70	274	177
972	2,630	1,795	270	74	305	187
973	2,884	1,985	295	84	318	202
974	3,023	2,032	307	96	370	218
975	3,409	2,288	332	113	417	259
976	3,729	2,512	364	123	446	285
977	4,067	2,726	374	139	514	314
978	4,625	3,059	414	170	623	359
979	5,366	3,598	472	193	735	368
980	6,063	4,098	491	236	835	403
981	6,847	4,571	546	291	1,004	435
982	7,324	4,768	616	337	1,111	491
983	7,882	4,989	626	389	1,302	576
984	8,620	5,431	690	475	1,411	613
985	9,687	6,064	752	560	1,617	694
1986	10,928	6,712	915	700	1,869	732
987	12,153	7,343	1,023	790	2,168	828
988	13,463	8,193	1,106	872	2,356	935
1989	14,976	8,990	1,223	995	2.697	1,071
990	16,285	9,636	1,324	1,128	3,006	1,191
991	17,584	10,232	1,473	1,205	3,367	1,307
992	18,816	11,090	1,491	1,280	3,547	1,409
993	19,948	11,953	1,559	1,361	3,589	1,486
994	21,039	12,658	1,566	1,419	3,815	1,580
1995	22,101	13,331	1,655	1,492	4,024	1,599
1996 (est.)	22,908	13,744	1,715	1,589	4,205	1,655
1997 (est.)	23,811	14,186	1,799	1,685	4,404	1,737

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Appendix table 5-2. Support for academic R&D, by sector: FYs 1960-97

				Source of support	ort	
		Federal	State/local		Academic	All other
	Total	Government	government	Industry	institutions	sources
		Millions of co	nstant 1992 dollars	S ^a		
960	2,772	1,738	365	172	275	223
961	3,223	2,112	401	169	296	245
962	3,781	2,564	443	167	330	276
963	4,462	3,137	487	169	367	301
964	5,200	3,740	538	163	420	339
965	5,911	4,303	573	164	497	373
966	6,730	4,948	612	165	581	424
967	7,295	5,351	623	182	687	452
968	7,875	5,761	630	202	799	484
969	7,805	5,612	691	210	782	509
970	7,781	5,488	730	203	810	550
971	7,923	5,464	808	222	868	561
972	7,956	5,429	815	225	922	564
973	8,359	5,755	854	243	923	585
974	8,178	5,498	830	260	1,000	590
975	8,359	5,611	813	277	1,024	634
976	8,528	5,744	832	282	1,019	651
977	8,649	5,797	795	295	1,094	667
978	9,197	6,083	824	337	1,238	714
979	9,850	6,605	866	355	1,349	675
980	10,216	6,905	827	397	1,408	679
981	10,509	7,016	838	447	1,540	667
982	10,499	6,836	883	483	1,593	704
983	10,801	6,837	858	533	1,784	790
984	11,375	7,166	911	627	1,862	809
985	12,355	7,735	959	714	2,062	885
986	13,556	8,326	1.135	868	2.318	909
987	14,653	8,854	1,234	953	2,615	998
988	15,689	9,547	1,289	1,017	2,746	1,090
989	16,745	10,051	1,368	1,112	3,016	1,197
990	17,477	10,342	1,421	1,210	3,226	1,279
991	18,098	10,532	1,516	1,240	3,465	1,345
992	18,816	11,090	1,491	1,280	3,547	1,409
993	19,435	11,646	1,519	1,326	3,496	1,448
994	20,030	12,051	1,491	1,350	3,633	1,505
995	20,540	12,389	1,538	1,387	3,739	1,486
996 (est.)	20,340	12,486	1,558	1,444	3,820	1,503
997 (est.)	21.091	12,466	1,594	1,444	3,901	1,503

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Appendix table 5-2. Support for academic R&D, by sector: FYs 1960-97

			S	ource of support		
		Federal	State/local		Academic	All other
	Total	Government	government	Industry	institutions	sources
		Per	centages			
960	100.0	62.7	13.2	6.2	9.9	8.0
961	100.0	65.5	12.5	5.2	9.2	7.6
962	100.0	67.8	11.7	4.4	8.7	7.3
963	100.0	70.3	10.9	3.8	8.2	6.8
964	100.0	71.9	10.4	3.1	8.1	6.5
965	100.0	72.8	9.7	2.8	8.4	6.3
966	100.0	73.5	9.1	2.4	8.6	6.3
967	100.0	73.3	8.5	2.5	9.4	6.2
968	100.0	73.2	8.0	2.6	10.1	6.1
969	100.0	71.9	8.9	2.7	10.0	6.5
970	100.0	70.5	9.4	2.6	10.4	7.1
971	100.0	69.0	10.2	2.8	11.0	7.1
972	100.0	68.2	10.2	2.8	11.6	7.1
973	100.0	68.8	10.2	2.9	11.0	7.0
974	100.0	67.2	10.2	3.2	12.2	7.2
975	100.0	67.1	9.7	3.3	12.2	7.6
976	100.0	67.4	9.8	3.3	11.9	7.6
977	100.0	67.0	9.2	3.4	12.6	7.7
978	100.0	66.1	9.0	3.7	13.5	7.8
979	100.0	67.1	8.8	3.6	13.7	6.9
980	100.0	67.6	8.1	3.9	13.8	6.6
981	100.0	66.8	8.0	4.3	14.7	6.4
982	100.0	65.1	8.4	4.6	15.2	6.7
983	100.0	63.3	7.9	4.9	16.5	7.3
984	100.0	63.0	8.0	5.5	16.4	7.5 7.1
985	100.0	62.6	7.8	5.8	16.7	7.1
986	100.0	61.4	7.8 8.4	6.4	17.1	6.7
987	100.0	60.4	8.4	6.5	17.1	6.8
988	100.0	60.9	8.2	6.5	17.5	6.9
989	100.0	60.0	8.2	6.6	18.0	7.2
990	100.0	59.2	8.1	6.9	18.5	7.2
991	100.0	58.2	8.4	6.9	19.1	7.3 7.4
992	100.0	58.9 50.0	7.9	6.8	18.9	7.5
993	100.0	59.9	7.8	6.8	18.0	7.4
994	100.0	60.2	7.4	6.7	18.1	7.5
995	100.0	60.3	7.5	6.8	18.2	7.2
996 (est.)	100.0	60.0	7.5	6.9	18.4	7.2
997 (est.)	100.0	59.6	7.6	7.1	18.5	7.3

^aSee appendix table 4-1 for gross domestic product implicit price deflators used to convert current dollars to constant 1992 dollars.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, annual series.

See figure 5-3.

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Appendix table 5-3. Sources of R&D funds at private and public institutions: 1975, 1985, and 1995

				Source of funds	i	
Year and institution type	Total	Federal Government	State/local government	Industry	Academic institutions	Other sources
		Millions of co	urrent dollars			
1975						
Private, total	1,244.6	960.5	34.1	43.2	76.5	130.3
Public, total	2,164.1	1,327.5	297.6	69.8	340.9	128.3
1985						
Private, total	3,402.2	2,574.6	68.2	217.4	289.2	252.8
Public, total	6,285.0	3,489.7	683.9	342.5	1,327.8	441.0
1995						
Private, total	7,194.3	5,238.4	173.1	486.4	644.6	651.7
Public, total	14,907.0	8,092.7	1,481.9	1,006.0	3,379.1	947.3
		Perce	ntages			
1975						
Private, total	100.0	77.2	2.7	3.5	6.1	10.5
Public, total	100.0	61.3	13.8	3.2	15.8	5.9
1985						
Private, total	100.0	75.7	2.0	6.4	8.5	7.4
Public, total	100.0	55.5	10.9	5.4	21.1	7.0
1995						
Private, total	100.0	72.8	2.4	6.8	9.0	9.1
Public, total	100.0	54.3	9.9	6.7	22.7	6.4

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, annual series.

Appendix table 5-4. **R&D expenditures at the top 100 academic institutions, by source of funds: 1995** (Millions of current dollars)

				So	urce of fun	ds	
Rank and academic institution	Institution type	Total	Federal Govern- ment	State/ local government	Industry	Academic institutions	All other sources
Total, all institutions		22,101	13,331	1,655	1,492	4,024	1,599
1 University of Michigan, all campuses	Public	443	276	9	29	98	31
2 University of Wisconsin-Madison	Public	404	229	38	13	81	43
3 University of Washington	Public	389	291	10	37	44	7
4 Massachusetts Institute of Technology	Private	371	274	*	53	16	28
5 Texas A&M University, all campuses	Public	363	137	81	31	105	8
6 University of California-San Diego	Public	357	284	9	11	27	26
7 Cornell University, all campuses	Private	344	207	49	18	38	32
8 Johns Hopkins University ^a	Private	342	273	3	11	15	41
9 University of Minnesota, all campuses10 Pennsylvania State University,	Public	337	195	50	23	46	23
all campuses	Public	331	187	10	50	83	0
Total, top 10 institutions		3,679	2,354	259	276	553	237
11 University of California-San Francisco	Public	330	224	20	14	33	38
12 Stanford University	Private	319	273	*	16	7	21
13 University of California-Los Angeles	Public	304	202	4	15	41	42
14 University of Arizona	Public	292	169	6	15	93	9
15 University of California-Berkeley	Public	291	158	29	14	71	20
16 Harvard University	Private	276	204	*	8	13	51
17 University of Pennsylvania	Private	272	201	5	12	24	30
18 University of Colorado, all campuses	Public	250	170	4	13	29	33
19 Ohio State University, all campuses	Public	246	123	28	22	39	35
20 University of Illinois at Urbana-Champaign	Public	246	139	29	12	54	12
Total, top 20 institutions		6,506	4,216	384	418	958	528
•		-,	.,				
21 Columbia University in the	Delivata	0.45	206	0	4	0	07
City of New York	Private Public	245 244	206 123	2 18	1 8	8 77	27 19
22 University of California-Davis				3		7 <i>7</i> 16	24
23 Yale University	Private	232	175		14 3		
24 University of Texas at Austin	Public	229 222	144 164	11 7		51 34	19 0
25 University of Southern California	Private			, 5	18 33	34 16	
26 Duke University	Private Public	219 212	149		26		17
all campuses	Public	212	105 94	6 55	25 25	75 36	0 0
, ,	Public	209	94 157	24	25 2	26	0
29 University of North Carolina at Chapel Hill	Private	209	147	24 5	22	26 15	21
30 Washington University	Frivate	8,737	5,678	520	571	1,312	655
• •		•	•			-	
31 University of Georgia	Public	206	58	40	11	97	1
32 Purdue University, all campuses33 Rutgers the State University of NJ,	Public	203	93	19	25	65	*
all campuses	Public	192	73	26	8	73	12
34 Baylor College of Medicine	Private	190	94	5	12	24	55
35 Louisiana State University, all campuses	Public	187	61	64	10	37	14
36 University of Pittsburgh, all campuses	Public	186	144	4	8	17	13
37 North Carolina State University at Raleigh	Public	180	69	67	26	17	*
38 Northwestern University	Private	174	90	3	7	55	18
39 University of Iowa	Public	165	103	5	11	35	11
40 Michigan State University	Public	163	74	27	7	42	12
Total, top 40 institutions		10,584	6,538	780	697	1,774	791

Appendix table 5-4. **R&D expenditures at the top 100 academic institutions, by source of funds: 1995** (Millions of current dollars)

					Sc	urce of fun	ds	
Ran	k and academic institution	Institution type	Total	Federal Govern- ment	State/ local government	Industry	Academic institutions	All other sources
41	University of Alabama at Birmingham	Public	159	107	4	19	11	17
	University of Rochester	Private	159	126	9	13	3	8
	Iowa State University	Public	155	59	42	8	42	4
	University of Florida	Public	154	79	11	11	47	6
	University of Tennessee University-Wide Administrative							
	Central Office	Public	151	76	27	11	28	10
	New York University	Private	149	94	2	6	18	29
47	Virginia Polytechnic Institute							
	and State University	Public	149	79	33	12	21	3
	Emory University	Private	148	93	4	11	19	21
49	Indiana University, all campuses	Public	146	85	2	6	32	20
	SUNY at Buffalo, all campuses	Public	144	76	12	13	16	27
Tota	al, top 50 institutions		12,097	7,413	925	807	2,012	936
51	Case Western Reserve University	Private	141	107	4	5	12	12
52	University of Connecticut, all campuses	Public	140	50	15	7	61	7
53	California Institute of Technology	Private	138	121	*	5	9	2
54	University of Virginia, all campuses	Public	137	85	5	15	14	16
55	University of New Mexico, all campuses	Public	129	91	4	3	26	5
56	University of Miami	Private	129	97	2	12	6	12
57	University of Chicago	Private	126	105	1	2	8	11
	Carnegie Mellon University	Private	126	85	8	18	5	10
59	University of Texas Southwestern							
	Medical Center Dallas	Public	125	79	*	15	6	25
60	Oregon State University	Public	123	69	28	3	14	9
Tota	al, top 60 institutions		13,411	8,301	993	893	2,174	1,047
61	University of Missouri, Columbia	Public	123	32	15	10	58	7
62	SUNY at Stony Brook, all campuses University of Texas MD	Public	123	77	3	6	31	7
	Anderson Cancer Center	Public	122	45	0	0	50	28
64	Colorado State University	Public	122	75	17	6	22	2
	University of Illinois at Chicago	Public	119	58	3	6	41	12
	University of Kentucky, all campuses	Public	112	50	9	12	36	5
	Vanderbilt University	Private	111	92	*	3	9	7
	University of California-Irvine	Public	110	70	4	9	15	12
	University of Maryland at Baltimore	Public	108	60	15	18	6	9
	University of Nebraska at Lincoln	Public	108	37	34	3	33	*
	al, top 70 institutions		14,569	8,895	1,093	966	2,474	1,135
	Wayne State University	Public	106	46	9	8	32	11
	University of Utah	Public	106	84	*	4	11	6
	Princeton University	Private	104	64	*	6	24	10
	Boston University	Private	104	83	*	9	0	11
75	Georgetown University	Private	102	74	*	6	15	7
	University of Oklahoma, all campuses	Public	102	37	11	6	35	14
	University of Kansas, all campuses	Public	101	42	8	8	37	5
78	Tulane University	Private	100	61	4	10	22	3
	Washington State University University of Medicine and	Public	97	49	4	3	33	9
	Dentistry of New Jersey	Public	96	46	6	8	26	11

Appendix table 5-4. **R&D expenditures at the top 100 academic institutions, by source of funds: 1995** (Millions of current dollars)

				So	urce of fun	ds	
Rank and academic institution	Institution type	Total	Federal Govern- ment	State/ local government	Industry	Academic institutions	All other sources
81 Yeshiva University	Private	95	72	0	2	12	9
82 Auburn University, all campuses	Public	93	28	*	3	57	4
83 University of South Florida	Public	93	30	8	5	45	6
84 Mount Sinai School of Medicine	Private	92	59	3	6	11	13
85 University of Cincinnati, all campuses	Public	91	55	3	9	19	6
86 University of Texas Health Science Center							
San Antonio	Public	87	54	9	9	11	4
87 Florida State University	Public	86	46	3	2	31	4
88 Clemson University	Public	83	29	15	5	29	4
89 Utah State University	Public	82	48	14	3	15	2
90 New Mexico State University,							
all campuses	Public	81	57	12	2	8	2
Total, top 90 institutions		16,471	9,960	1,200	1,080	2,946	1,276
91 Woods Hole Oceanographic Institution	Private	80	73	*	0	1	6
92 University of South Carolina, all campuses	Public	80	44	3	8	22	3
93 University of California-Santa Barbara	Public	79	63	1	3	7	5
94 University of Hawaii at Manoa	Public	78	44	27	0	4	3
95 Rockefeller University	Private	77	41	*	4	17	14
96 Tufts University	Private	77	50	2	5	14	6
97 Arizona State University, main	Public	77	35	*	7	31	3
98 Virginia Commonwealth University	Public	77	47	2	6	18	4
99 Oklahoma State University,							
all campuses	Public	76	19	8	3	43	3
100 Oregon Health Sciences University	Public	75	49	*	5	16	4
Total, top 100 institutions		17,247	10,427	1,243	1,121	3,120	1,326

^{* =} less than \$1 million

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, *Academic Science and Engineering R&D Expenditures: Fiscal Year 1995*, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, unpublished tabulations.

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^aThese figures exclude the Applied Physics Laboratory (APL) at Johns Hopkins University, which is similar to a federally funded research and development center and dominates the R&D performed at the university. In 1995, APL had total R&D expenditures of \$447 million, of which \$434 million were provided by federal sources.

Appendix table 5-5. Total, federal, and nonfederal R&D expenditures at academic institutions, by field and source of funds: 1995

	Total	R&D	Millions	of dollars	Perce	ntages
Field	Millions of dollars	Percent	Federal	Non- federal ^a	Federal	Non- federal ^a
TOTAL SCIENCE & ENGINEERING	22,101.2	100.0	13,331.2	8,770.1	60.3	39.7
Total sciences	18,556.0	84.0	11,196.4	7,359.6	60.3	39.7
Physical sciences	2,241.4	10.1	1,631.5	609.9	72.8	27.2
Astronomy	307.4	1.4	208.6	98.8	67.9	32.1
Chemistry	773.1	3.5	535.0	238.1	69.2	30.8
Physics	969.0	4.4	750.6	218.3	77.5	22.5
Other	192.0	0.9	137.3	54.7	71.5	28.5
Mathematics	283.6	1.3	206.0	77.6	72.6	27.4
Computer sciences	679.7	3.1	477.7	202.0	70.3	29.7
Environmental sciences	1,434.2	6.5	962.1	472.1	67.1	32.9
Atmospheric sciences	208.2	0.9	163.5	44.7	78.5	21.5
Earth sciences	460.4	2.1	269.1	191.3	58.5	41.5
Oceanography	481.1	2.2	338.3	142.7	70.3	29.7
Other	284.5	1.3	191.1	93.4	67.2	32.8
Life sciences	12,133.2	54.9	7,119.7	5,013.5	58.7	41.3
Agricultural sciences	1,734.2	7.8	526.8	1,207.4	30.4	69.6
Biological sciences	3,835.7	17.4	2,492.9	1,342.7	65.0	35.0
Medical sciences	6.057.2	27.4	3,807.3	2.249.9	62.9	37.1
Other	506.1	2.3	292.7	213.4	57.8	42.2
Psychology	370.2	1.7	250.0	120.2	67.5	32.5
Social sciences	1,018.4	4.6	391.9	626.5	38.5	61.5
Economics	244.1	1.1	79.0	165.1	32.4	67.6
Political science	177.0	0.8	63.7	113.3	36.0	64.0
Sociology	216.3	1.0	105.2	111.1	48.6	51.4
Other	380.9	1.7	143.9	237.0	37.8	62.2
Other sciences	395.4	1.8	157.6	237.8	39.9	60.1
Total engineering	3.545.2	16.0	2.134.7	1,410.5	60.2	39.8
Aeronautical/astronautical	227.5	1.0	170.8	56.6	75.1	24.9
Chemical	296.2	1.3	160.9	135.3	54.3	45.7
Civil	427.9	1.9	184.5	243.4	43.1	56.9
Electrical/electronic	790.1	3.6	518.0	272.1	65.6	34.4
Mechanical	508.9	2.3	329.1	179.8	64.7	35.3
Materials	325.7	1.5	171.6	154.1	52.7	47.3
Other	968.9	4.4	599.7	369.2	61.9	38.1

^aSee appendix table 5-2 for detail on nonfederal sources.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, unpublished tabulations.

Appendix table 5-6. Expenditures for academic R&D, by field: 1985-95

ERING	Millions of current dollars ,153 13,463 14,9 ,261 11,367 12,5 ,398 1,554 1,6	ıt dollars						
BERING 9,687 10,928 8,269 9,287 1,148 1,287 10,287								
8,269 9,287 1,148 1,287 96 102 422 470 551 631 80 85 128 152 281 321 705 776 108 121 254 274 258 280 86 101 5,279 5,891		14,976	16,285	17,584	18,816	19,948	21,039	22,101
1,148 1,287 96 102 422 470 551 631 80 85 128 152 281 321 705 776 108 121 254 274 258 280 86 101 86 101 5,279 5,891		12,584	13,629	14,677	15,754	16,793	17,691	18,556
96 102 422 470 551 631 80 85 128 152 281 321 705 776 108 121 254 274 258 280 86 101 5,279 5,891		1,647	1,807	1,939	2,055	2,130	2,174	2,241
422 470 551 631 80 85 128 152 281 321 705 776 108 121 254 274 258 280 86 101 5,279 5,891		137	170	211	238	259	269	307
551 631 80 85 128 152 281 321 705 776 108 121 254 274 258 280 86 101 5,279 5,891 999 1,089		909	648	671	704	740	761	773
80 85 128 152 281 321 705 776 108 121 254 274 258 280 86 101 86 101 5,279 5,891		786	842	881	921	940	951	696
128 152 281 321 705 776 108 121 254 274 258 280 86 101 5,279 5,891		117	147	176	191	191	193	192
281 321 705 776 108 121 254 274 258 280 86 101 5,279 5,891		215	222	230	248	272	282	284
705 776 108 121 254 274 258 280 86 101 5,279 5,891	372 408	473	515	554	556	809	650	089
254 274 274 280 86 101 86 101 86 101 86 101 86 101 86 101 86 101 86 101 86 108		1,003	1,068	1,117	1,240	1,317	1,407	1,434
254 274 258 280 86 101 5,279 5,891		165	173	175	194	210	207	208
258 280 86 101 86 5,279 5,891 999 1,089		324	354	384	413	416	459	460
86 101 5,279 5,891 999 1,089		359	377	390	428	459	455	481
5,279 5,891		156	163	169	205	232	285	284
999 1,089		8,061	8,726	9,472	10,196	10,851	11,493	12,133
		1,282	1,349	1,458	1,512	1,559	1,661	1,734
1,946		2,640	2,859	3,064	3,303	3,535	3,733	3,836
2,615		3,819	4,154	4,546	4,964	5,323	5,637	6,057
		321	363	404	417	433	462	909
		234	253	283	328	350	357	370
		633	203	750	815	968	951	1,018
136		187	201	209	222	231	241	244
69 69		103	115	125	142	151	162	177
		119	132	156	163	183	195	216
		224	255	260	288	331	352	381
		318	336	332	315	368	378	395
Total engineering 1,418 1,641 1,892		2,392	2,656	2,907	3,062	3,155	3,348	3,545
94		148	163	180	196	212	220	227
		194	218	244	261	274	280	296
		245	284	315	339	371	401	428
395		262	663	629	704	869	742	790
		343	391	421	451	483	499	609
	NA	N A	274	304	294	299	310	326
		867	663	764	817	818	897	696

Appendix table 5-6. Expenditures for academic R&D, by field: 1985-95

Millions of constant 1992 dollars: 12,355 13,556 14,653 15,689 16,745 17,477 18,098 18,816 19,435 7 10,547 11,556 14,653 15,689 16,745 17,477 18,098 18,816 19,435 1 10,547 1,596 1,686 1,811 1,842 1,895 16,99 1,8816 19,435 2,822 538 583 619 659 678 695 690 704 721 102 105 124 143 131 158 181 191 186 103 160 166 167 172 238 227 248 285 207 221 361 368 367 367 371 361 368 375 378 374 368 374 378 378 374 361 368 374 378 374 378 374 378 374 378 374	Field	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NAG 12,355 13,566 14,653 15,689 16,747 17,477 18,098 18,11 18,465 16,466 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,11 18,46 18,12 18,46 18,41 18,46				Millions of	constant 19	92 dollars ^a						
10.547 11.521 12.372 13.246 14,070 14,656 15,554 16,361 16,361 16,361 16,361 16,361 16,361 16,361 16,362 16,362 16,362 16,363 16,365 2,074 2,075 2,074 2,075 2,074 2,075 2,074 2,075 2,074 2,075 2,075 2,074 2,075 2,074 2,075 2,074 2,075 2,074 2,075 2,074 2,075 2,074 2,075 2,075 2,074 2,075 2,074 2,075 2,0		12,355	13,556	14,653	15,689	16,745	17,477	18,098	18,816	19,435	20,030	20,540
1,465 1,566 1,686 1,811 1,842 1,939 1,995 2,055 2,075 1,23 126 1,11 1,48 154 184 154 188 2,17 2,38 2,52 703 782 812 862 879 903 907 921 916 102 108 214 212 243 248 265 571 556 593 163 188 214 212 243 248 371 196 907 921 916 163 188 214 242 249 499	Total sciences	10,547	11,521	12,372	13,246	14,070	14,626	15,107	15,754	16,361	16,842	17,245
123 126 131 148 154 183 217 228 252 538 583 619 669 678 6093 907 901 901 901 901 901 901 901 901 901 901 901 901 901 901 902 902 903 901 903 901 903 901 903 901 903 901 903 901 903 903 904 903	Physical sciences	1,465	1,596	1,686	1,811	1,842	1,939	1,995	2,055	2,075	2,070	2,083
538 583 619 659 678 699 704 721 703 782 184 482 879 903 907 901 902	Astronomy	123	126	131	148	154	183	217	238	252	256	286
703 782 812 862 879 903 907 921 916 102 105 124 143 131 158 181 191 186 102 105 124 143 132 240 286 552 571 556 593 388 399 449 476 528 552 571 566 593 900 963 1,011 1,042 1,122 1,146 1,150 1,240 1,283 329 347 361 388 401 405 401 406 401 406 401 406 401 406 401 406 406 407 406 407 406 407 406 407 406 407 406 407 406 407 406 407 406 407 406 407 406 407 407 406 407 406 407 407 408	Chemistry	538	583	619	629	678	969	069	704	721	724	718
102 105 124 143 131 158 181 191 186 163 188 214 232 240 238 527 528 527 578 289 358 399 498 4101 1,042 1,122 1,146 1,150 1,240 1,283 138 150 160 161 185 186 180 194 205 324 340 342 343 362 380 399 447 109 126 160 161 185 186 194 126 128 109 126 160 161 185 189 477 477 109 126 149 176 174 175 174 205 226 1,01 1,01 1,042 1,122 1,146 1,150 1,240 1,289 147 1,02 1,126 1,48 40 40	Physics	703	782	812	862	879	903	206	921	916	902	901
163 188 214 232 240 238 237 248 265 358 399 449 476 528 552 571 556 583 900 963 1,011 1,042 1,122 1,146 1,50 1,24 1,26 324 340 342 343 362 380 395 413 406 324 340 342 343 362 380 395 413 406 324 340 342 343 362 380 395 413 406 324 347 346 406 401 405 406 406 6,733 7,308 7,872 8,457 9,148 4,664 5,149 1,517 1,274 1,351 1,371 1,448 1,501 1,519 1,519 2,927 3,444 3,617 3,96 3,44 3,61 3,96 3,44	Other	102	105	124	143	131	158	181	191	186	184	178
358 399 449 476 528 552 571 556 593 900 963 1,011 1,042 1,122 1,146 1,150 1,240 1,283 324 340 342 343 362 386 401 405 419 205 329 347 361 388 401 405 401 428 447 109 126 149 1,571 1,448 1,501 10,196	Mathematics	163	188	214	232	240	238	237	248	265	269	264
900 963 1,011 1,042 1,122 1,146 1,150 1,240 1,283 324 340 342 343 342 349 396 196 194 205 329 347 361 38 401 405 401 428 447 109 126 149 150 174 175 174 205 226 6,733 7,308 7,872 8,457 9,013 9,364 9,749 10,196 10,571 1,224 1,351 1,371 1,448 1,501 1,512 1,519 2,272 2,415 2,585 2,806 2,954 3,608 3,153 3,444 2,957 3,244 3,617 3,936 4,270 4,488 4,680 4,964 5,186 2,957 3,244 3,617 3,936 4,270 4,488 4,680 4,964 5,186 2,957 3,244 3,617 3,936 4,	Computer sciences	358	399	449	476	528	552	571	556	593	619	632
138 150 160 161 185 186 180 194 205 324 340 342 343 362 380 395 413 406 329 347 349 150 174 175 174 205 447 109 126 149 150 174 175 174 205 447 1,274 1,351 1,371 1,448 1,501 1,512 1,519 2,272 2,415 2,885 2,806 2,951 3,068 3,153 3,449 10,196 10,571 2,272 2,415 2,885 2,806 2,951 3,068 3,153 3,448 3,169 3,449 10,571 1,519 2,272 2,415 2,885 2,806 2,951 3,068 3,153 3,444 3,617 3,968 3,168 3,184 4,179 4,680 4,964 5,186 2,186 2,272 2,272 2,272 2,24	Environmental sciences	006	963	1,011	1,042	1,122	1,146	1,150	1,240	1,283	1,339	1,333
324 340 342 362 380 386 413 406 329 347 361 388 401 405 401 428 447 109 126 148 361 388 401 405 401 428 447 109 126 148 150 174 174 205 226 227 2415 2,585 2,806 2,951 3,088 3,153 3,444 1,512 1,519 1,519 1,519 1,519 1,519 1,519 1,519 1,519 1,519 1,519 1,519 1,519 2,519 2,646 2,951 3,084 3,148 1,519	Atmospheric sciences	138	150	160	161	185	186	180	194	205	197	193
329 347 361 388 401 405 401 428 447 109 126 149 150 174 175 174 205 226 1,274 1,351 1,371 1,448 1,501 1,512 1,512 1,512 2,272 2,415 2,585 2,806 2,951 3,068 3,153 3,404 5,186 2,272 2,415 2,585 2,806 2,951 3,068 4,152 1,512 1,512 1,512 1,512 1,512 1,514 4,168 1,601 1,512	Earth sciences	324	340	342	343	362	380	395	413	406	437	428
109 126 149 150 174 175 174 205 226 6,733 7,308 7,872 8,457 9,013 9,364 9,749 10,196 10,571 1,274 1,351 1,351 1,371 1,448 1,501 1,512 1,519 2,272 2,415 2,585 2,806 2,951 3,163 3,444 1,512 1,519 1,519 1,519 2,97 3,244 3,617 3,936 4,270 4,468 4,680 4,964 5,186 2,02 2,11 2,26 248 261 271 291 3,44 5,186 202 2,11 2,26 248 261 271 291 341 417 418 419 5,186 344 417 418 418 418 418 418 418 418 418 418 418 418 418 418 418 419 419 419 419 <	Oceanography	329	347	361	388	401	405	401	428	447	433	447
6,733 7,308 7,872 8,457 9,013 9,364 9,749 10,196 10,571 1,274 1,351 1,371 1,433 1,448 1,501 1,512 1,519 2,272 2,415 2,585 2,806 2,951 3,068 3,153 3,303 3,444 2,957 3,244 3,617 3,936 4,270 4,680 4,964 5,186 2,957 2,957 3,244 3,617 3,936 4,570 4,680 4,964 5,186 2,957 2,957 2,96 2,95 3,96 4,15 4,964 5,186 2,957 2,96 2,97 4,96 4,96 4,96 5,186 5,186 489 574 606 643 708 275 815 873 56 151 168 190 209 215 215 147 85 98 101 116 124 129 142 147	Other	109	126	149	150	174	175	174	205	226	272	264
1,274 1,351 1,371 1,433 1,448 1,501 1,512 1,519 2,272 2,415 2,585 2,806 2,951 3,068 3,153 3,303 3,444 2,272 2,415 2,585 2,806 2,951 3,068 3,153 3,303 3,444 2,957 3,244 3,617 3,936 4,270 4,458 4,680 4,964 5,186 2,957 2,94 3,617 3,936 427 2,91 4,964 5,186 2,92 2,11 2,26 2,48 2,61 2,71 2,91 4,964 5,186 489 574 606 643 708 271 291 222 225 167 85 98 101 116 124 129 147 447 59 116 115 126 250 274 268 288 322 538 2,83 2,943 2,675 2,851	Life sciences	6,733	7,308	7,872	8,457	9,013	9,364	9,749	10,196	10,571	10,942	11,276
2,272 2,415 2,585 2,806 2,951 3,068 3,153 3,344 2,957 3,244 3,617 3,936 4,270 4,458 4,680 4,964 5,186 231 297 318 345 359 390 415 417 422 202 211 226 248 261 271 291 328 341 489 574 606 643 708 775 815 341 76 85 98 101 116 124 129 142 147 95 119 115 126 133 141 160 163 147 95 119 115 126 250 274 268 288 322 238 283 309 337 356 360 341 315 359 103 117 118 1243 2,675 2,851 2,992 3,074	Agricultural sciences	1,274	1,351	1,351	1,371	1,433	1,448	1,501	1,512	1,519	1,581	1,612
2,957 3,244 3,617 3,936 4,270 4,458 4,680 4,964 5,186 231 297 318 345 359 390 415 417 422 202 211 226 248 261 271 291 328 341 489 574 606 643 708 755 772 815 873 151 168 180 190 209 215 215 222 225 151 168 180 101 116 124 129 142 147 95 119 115 126 133 141 160 163 179 167 201 213 226 250 274 268 288 322 238 283 339 337 360 341 315 362 103 117 130 143 267 284 251 261	Biological sciences	2,272	2,415	2,585	2,806	2,951	3,068	3,153	3,303	3,444	3,554	3,565
231 297 318 345 359 390 415 417 422 202 211 226 248 261 271 291 328 341 489 574 606 643 708 755 772 815 873 76 85 98 101 116 124 129 142 147 95 119 115 126 133 141 160 163 179 167 201 213 226 250 274 268 288 322 167 201 213 226 250 274 268 288 322 238 283 309 337 356 360 341 315 359 103 117 130 143 166 175 185 196 207 1148 164 179 189 274 305 324 339 <td>Medical sciences</td> <td>2,957</td> <td>3,244</td> <td>3,617</td> <td>3,936</td> <td>4,270</td> <td>4,458</td> <td>4,680</td> <td>4,964</td> <td>5,186</td> <td>2,367</td> <td>5,629</td>	Medical sciences	2,957	3,244	3,617	3,936	4,270	4,458	4,680	4,964	5,186	2,367	5,629
202 211 226 248 261 271 291 328 341 489 574 606 643 708 755 772 815 873 151 168 180 190 209 215 215 222 225 76 85 98 101 116 124 129 142 147 95 119 115 126 133 141 160 163 179 167 201 213 226 250 274 268 288 322 238 283 309 337 356 360 341 315 359 103 117 130 143 166 175 185 196 207 1148 164 179 189 217 234 251 261 261 430 221 220 224 339 362 324 339 <td>Other</td> <td>231</td> <td>297</td> <td>318</td> <td>345</td> <td>329</td> <td>330</td> <td>415</td> <td>417</td> <td>422</td> <td>440</td> <td>470</td>	Other	231	297	318	345	329	330	415	417	422	440	470
489 574 606 643 708 755 772 815 873 151 168 180 190 209 215 222 225 76 85 98 101 116 124 129 142 147 95 119 115 126 250 274 268 288 322 167 201 213 226 250 274 268 288 322 238 283 309 337 356 360 341 315 359 238 2,035 2,281 2,443 2,675 2,851 2,992 3,074 103 117 130 143 166 175 185 196 207 148 164 179 189 217 234 251 261 261 261 267 430 249 544 593 665 711 699	Psychology	202	211	226	248	261	271	291	328	341	340	344
151 168 180 190 209 215 222 225 76 85 98 101 116 124 129 142 147 95 119 115 126 250 274 268 288 322 167 201 213 226 250 274 268 288 322 238 283 309 337 360 341 315 359 160 2,035 2,281 2,443 2,675 2,851 2,992 3,074 103 117 130 143 166 175 185 196 207 148 164 179 189 217 234 251 261 261 267 195 221 230 261 274 305 374 680 430 430 544 593 665 711 699 704 680	Social sciences	489	574	909	643	208	755	772	815	873	906	946
76 85 98 101 116 124 129 142 147 95 119 115 126 133 141 160 163 179 167 201 213 226 250 274 268 288 322 238 283 309 337 356 360 341 315 359 1,808 2,035 2,281 2,443 2,675 2,851 2,992 3,062 3,074 103 117 130 143 166 175 185 196 207 148 164 179 189 217 234 251 261 267 195 221 230 261 274 305 324 339 362 430 490 544 593 665 711 699 704 680 85 283 331 354 419 433 451	Economics	151	168	180	190	209	215	215	222	225	230	227
95 119 115 126 133 141 160 163 179 167 201 213 226 250 274 268 288 322 238 283 309 337 356 360 341 315 359 1,808 2,035 2,281 2,443 2,675 2,851 2,992 3,062 3,074 103 117 130 143 166 175 185 196 207 148 164 179 189 217 234 251 261 267 195 221 230 261 274 305 324 339 362 430 490 544 593 665 711 699 704 680 105 283 331 354 419 433 451 470 106 107 108 108 108 108 108 108	Political science	9/	85	86	101	116	124	129	142	147	154	165
167 201 213 226 250 274 268 288 322 238 283 309 337 356 360 341 315 359 1,808 2,035 2,281 2,443 2,675 2,851 2,992 3,062 3,074 103 117 130 143 166 175 185 196 207 118 164 179 189 217 234 251 261 267 195 221 230 261 274 305 324 339 362 430 490 544 593 665 711 699 704 680 105 283 331 354 419 433 451 470 106 107 108 108 108 108 108 108 108 108 108 108 108 108 108 108 108 108 </th <td>Sociology</td> <td>92</td> <td>119</td> <td>115</td> <td>126</td> <td>133</td> <td>141</td> <td>160</td> <td>163</td> <td>179</td> <td>186</td> <td>201</td>	Sociology	92	119	115	126	133	141	160	163	179	186	201
238 283 309 337 356 360 341 315 359 1,808 2,035 2,281 2,443 2,675 2,851 2,992 3,062 3,074 103 117 130 143 166 175 185 196 207 117 128 179 189 217 234 251 261 267 195 221 230 261 274 305 324 339 362 430 490 544 593 665 711 699 704 680 265 283 331 354 419 433 451 470 NA NA NA NA 294 313 294 291	Other	167	201	213	226	250	274	268	288	322	332	354
1,808 2,035 2,281 2,443 2,675 2,851 2,992 3,062 3,074 103 117 130 143 166 175 185 196 207 148 164 179 189 217 234 251 261 267 195 221 230 261 274 305 324 339 362 196 430 544 593 665 711 699 704 680 196 283 331 354 313 294 291 197 198 198 198 198 198 198 198 283 331 354 339 362 198 283 331 354 419 433 451 470 198 198 198 198 198 198 198 198 198 198 198 198 198 198 198 198 199 198 198 198 198 198 198 198 198 199 199 198 198 198 198 198 198 198 <	Other sciences	238	283	309	337	326	360	341	315	329	329	367
103 117 130 143 166 175 185 196 207 148 164 179 189 217 234 251 261 267 195 221 230 261 274 305 324 339 362 430 490 544 593 665 711 699 704 680 265 283 331 354 384 419 433 451 470 NA NA NA NA NA 294 313 294 291	Total engineering	1,808	2,035	2,281	2,443	2,675	2,851	2,992	3,062	3,074	3,188	3,295
al. 148 164 179 189 217 234 251 267 Al/electronic 430 490 544 593 665 711 699 704 680 ical 265 283 331 354 384 419 433 451 470 s 3 3 3 3 3 3 433 294 291	Aeronautical/astronautical	103	117	130	143	166	175	185	196	207	210	211
micelectronic 430 221 230 261 274 305 324 339 362 al/electronic 430 490 544 593 665 711 699 704 680 ical 265 283 331 354 384 419 433 451 470 s 8 n N N N 294 313 294 291	Chemical	148	164	179	189	217	234	251	261	267	266	275
	Civil	195	221	230	261	274	305	324	339	362	382	398
	Electrical/electronic	430	490	544	593	999	711	669	704	089	206	734
NA NA NA NA 294 313 294 291	Mechanical	265	283	331	354	384	419	433	451	470	475	473
	Materials	Ą	A A	A V	A V	Ϋ́	294	313	294	291	295	303
667 761 867 902 970 712 786 817 797	Other	299	761	867	905	920	712	786	817	797	854	006

Appendix table 5-6. Expenditures for academic R&D, by field: 1985-95

	0061	0061	100		200	000		1332	200	-	000
			а.	Percentages							
TOTAL SCIENCE & ENGINEERING	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	_
Total sciences	85.4	85.0	84.4	84.4	84.0	83.7	83.5	83.7	84.2	84.1	
Physical sciences	11.9	11.8	11.5	11.5	11.0	11.1	11.0	10.9	10.7	10.3	
Astronomy	1.0	6.0	6.0	6.0	6.0	1.0	1.2	1.3	1.3	1.3	
Chemistry	4.4	4.3	4.2	4.2	4.0	4.0	3.8	3.7	3.7	3.6	
Physics	2.5	5.8	5.5	5.5	5.2	5.2	5.0	4.9	4.7	4.5	
Other	0.8	0.8	0.8	6.0	0.8	6.0	1.0	1.0	1.0	0.9	
Mathematics	1.3	4.1	1.5	1.5	4.1	4.1	1.3	1.3	4.1	6.	
Computer sciences	5.9	2.9	3.1	3.0	3.2	3.2	3.2	3.0	3.1	3.1	
Environmental sciences	7.3	7.1	6.9	9.9	6.7	9.9	6.4	9.9	9.9	6.7	
Atmospheric sciences	- -	[[1.0	[1.1	1.0	1.0	1.	1.0	
Earth sciences	2.6	2.5	2.3	2.2	2.2	2.2	2.2	2.2	2.1	2.2	
Oceanography	2.7	2.6	2.5	2.5	2.4	2.3	2.2	2.3	2.3	2.2	
Other	6.0	6.0	1.0	1.0	1.0	1.0	1.0	1.1	1.2	1.4	
Life sciences	54.5	53.9	53.7	53.9	53.8	53.6	53.9	54.2	54.4	54.6	
Agricultural sciences	10.3	10.0	9.2	8.7	8.6	8.3	8.3	8.0	7.8	7.9	
Biological sciences	18.4	17.8	17.6	17.9	17.6	17.6	17.4	17.6	17.7	17.7	
Medical sciences	23.9	23.9	24.7	25.1	25.5	25.5	25.9	26.4	26.7	26.8	
Other	1.9	2.2	2.2	2.2	2.1	2.2	2.3	2.2	2.2	2.2	
Psychology	1.6	1.6	1.5	1.6	1.6	1.6	1.6	1.7	1.8	1.7	
Social sciences	4.0	4.2	4.1	4.1	4.2	4.3	4.3	4.3	4.5	4.5	
Economics	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	[:	
Political science	9.0	9.0	0.7	9.0	0.7	0.7	0.7	0.8	0.8	0.8	
Sociology	8.0	6.0	0.8	0.8	0.8	0.8	6.0	6.0	6.0	6.0	
Other	1.4	1.5	1.5	4.1	1.5	1.6	1.5	1.5	1.7	1.7	
Other sciences	1.9	2.1	2.1	2.2	2.1	2.1	1.9	1.7	1.8	1.8	
Total engineering	14.6	15.0	15.6	15.6	16.0	16.3	16.5	16.3	15.8	15.9	
Aeronautical/astronautical	0.8	6.0	6.0	6.0	1.0	1.0	1.0	1.0		1.0	
Chemical	1.2	1.2	1.2	1.2	1.3	1.3	1.4	1.4	4.1	1.3	
Civil	1.6	1.6	1.6	1.7	1.6	1.7	1.8	1.8	1.9	1.9	
Electrical/electronic	3.5	3.6	3.7	3.8	4.0	4.1	3.9	3.7	3.5	3.5	
Mechanical	2.1	2.1	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.4	
Materials	¥	Ϋ́Z	Ϋ́	∀ Z	ΥZ	ΑN	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ϋ́
Other	5.4	5.6	5.9	5.8	5.8	4.1	4.3	4.3	4.1	4.3	

^eSee appendix table 4-1 for gross domestic product implicit price deflators used to convert current dollars to constant 1992 dollars.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, unpublished tabulations.

See figure 5-4.

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Appendix table 5-7. Percentage of academic R&D funds federally financed, by field: 1975-95

Field	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TOTAL S&E	67.1	67.4	67.0	66.1	67.1	9.79	8.99	65.1	63.3	63.0	62.6	61.4	60.4	6.09	0.09	59.2	58.2	58.9	59.9	60.2	60.3
Total sciences	0.79	67.4	67.0	62.9	8.99	67.4	66.5	64.8	65.9	62.8	62.8	61.7	2.09	61.3	60.4	59.5	58.6	59.3	60.1	60.3	60.3
Physical sciences	81.4	80.5	80.0	79.0	81.5	81.9	80.8	78.9	7.77	78.1	77.5	76.4	75.2	74.5	72.7	72.8	71.4	71.8	71.0	71.9	72.8
Astronomy	73.4	8.69	71.8	71.6	74.8	75.6	71.0	9.07	0.89	66.1	0.79	68.5	65.7	66.1	64.0	66.1	64.4	66.5	63.8	9.79	6.79
Chemistry	8.92	77.0	76.2	75.4	75.8	7.7.7	76.0	74.7	73.8	75.1	74.2	72.1	71.7	71.3	9.69	68.7	67.3	68.1	68.2	68.3	69.2
Physics	86.4	85.3	85.2	84.7	86.5	86.8	86.4	83.5	82.1	82.3	82.2	80.9	79.4	78.4	77.1	77.5	77.1	6.97	75.3	76.2	77.5
Other	77.7	77.2	73.7	69.7	82.7	78.7	81.1	81.2	80.5	80.1	75.1	75.8	75.1	74.7	69.5	71.8	66.4	2.79	70.3	8.07	71.5
Mathematics	78.6	77.4	7.77	75.1	9.77	78.4	77.8	74.5	71.9	75.0	75.9	75.5	74.4	75.4	73.3	72.6	74.1	74.0	74.6	72.9	72.6
Computer sci	74.3	74.0	9.79	61.1	6.07	70.4	72.4	74.2	74.6	72.7	2.69	72.4	69.1	70.8	68.5	66.5	0.79	68.3	9.69	71.3	70.3
Environmental sci	70.8	73.4	74.7	72.5	72.6	73.1	71.1	70.1	69.1	69.1	67.2	9.99	65.0	62.9	64.8	63.8	62.7	63.7	0.99	67.4	67.1
Atmospheric sci	Ϋ́	Α	Ž	Ž	Ϋ́	84.1	77.0	6.62	78.4	80.7	79.8	81.2	82.0	81.2	6.77	7.5.7	74.1	72.1	76.3	9.62	78.5
Earth sci	Ϋ́	N	ΑN	Ž	Ϋ́	2.69	67.1	64.9	62.4	61.4	2.09	58.3	56.2	59.3	57.7	57.7	26.7	57.7	58.4	58.6	58.5
Oceanography	¥	Α̈́	Ž	Ž	Ϋ́	77.6	77.9	77.4	9.92	76.4	72.7	74.3	72.6	71.6	72.5	69.4	9.79	71.6	71.8	71.1	70.3
Other	70.8	73.4	74.7	72.5	72.6	59.1	58.0	53.5	54.2	54.0	53.9	50.3	48.9	49.8	48.1	51.0	52.9	51.6	58.6	0.79	67.2
Life sciences	65.1	65.7	65.3	64.1	64.1	64.9	64.0	62.4	60.2	60.1	60.4	59.3	58.8	9.69	59.3	58.3	57.2	58.0	58.9	58.7	58.7
Agricultural sci	29.4	29.7	28.8	29.8	30.2	30.9	29.7	29.5	28.4	28.2	29.4	26.8	26.6	27.4	27.3	26.1	25.9	27.6	28.9	29.9	30.4
Biological sci	72.5	73.5	74.5	73.0	72.6	74.0	73.0	71.4	69.5	69.5	6.79	67.4	66.2	8.99	65.8	64.5	63.7	64.7	65.3	9.59	65.0
Medical sci	75.6	75.5	74.9	73.1	73.7	74.4	74.1	72.0	68.9	9.79	68.0	9.99	65.4	65.5	65.5	64.3	62.7	62.7	63.3	62.7	62.9
Other	71.8	72.6	71.7	70.4	70.1	67.3	67.5	64.0	61.0	62.9	0.09	61.3	59.8	61.7	61.0	59.1	0.09	58.2	59.3	58.7	57.8
Psychology	8.92	76.2	74.8	71.4	72.3	73.3	72.7	68.1	0.99	67.4	6.99	0.79	66.1	62.9	65.5	64.8	65.8	65.4	0.79	9.79	67.5
Social sciences	55.2	52.7	51.6	9.09	53.0	53.8	51.0	45.6	42.6	39.8	40.1	37.4	33.6	34.2	33.5	32.2	33.7	34.5	37.7	37.8	38.5
Economics	48.2	44.5	43.8	46.9	48.4	48.8	45.4	43.7	39.6	39.1	37.0	33.5	29.1	30.2	29.1	27.1	28.6	29.8	33.4	31.5	32.4
Political science	41.8	42.2	46.2	43.4	46.0	43.4	45.0	37.3	36.8	33.9	33.1	29.4	29.7	29.0	25.0	22.0	22.8	24.7	28.3	31.0	36.0
Sociology	65.5	62.1	61.1	2.09	63.4	65.0	60.5	58.5	55.3	54.0	53.5	51.2	46.2	44.1	45.2	45.5	46.3	50.0	49.7	49.5	48.6
Other	55.9	54.8	52.9	49.4	52.2	54.1	52.3	42.8	39.3	35.3	38.5	35.8	32.4	34.4	34.9	33.9	35.5	34.2	38.5	38.7	37.8
Other sciences	57.2	59.5	54.9	58.1	54.9	53.6	56.5	56.5	52.7	48.5	49.3	47.1	44.8	41.9	40.1	41.1	33.8	32.4	35.1	36.2	39.9
Total engineering Aeronautical/	68.1	67.3	9.79	8.79	68.7	9.89	68.5	67.2	65.5	64.0	61.2	59.6	58.8	58.7	57.8	57.4	56.3	57.2	58.9	59.4	60.2
astronautical	Ϋ́	Ν	Ϋ́	Ž	¥	79.5	80.0	79.1	78.7	78.2	76.4	77.0	74.1	76.3	77.5	7.77	76.4	7.97	75.1	75.4	75.1
Chemical	Ν	Ν	Ϋ́	¥	Ϋ́	64.4	6.99	62.0	59.5	59.1	55.6	55.4	51.7	52.6	52.1	9.09	48.4	48.4	52.2	53.7	54.3
Civil	Υ V	Ϋ́	Α	¥	Ϋ́	64.0	26.8	51.5	50.4	51.8	51.5	49.6	47.0	45.6	41.7	41.2	39.3	42.3	41.6	40.7	43.1
Electrical/	:	:	:	:	;	1	I		e I	i	ļ	I			1			(I	I	1
electronic	₹ :	Z :	₹ Z	₹ Z	₹ Z	7.5.7	75.9	77.1	73.8	71.0	2.79	62.9	64.8	64.9	65.0	65.1	64.2	63.9	65.7	62.9	65.6
Mechanical	₹ Z	Y V	₹ Z	₹ Z	₹ Z	67.0	67.5	68.3	67.1	66.5	64.6	64.9	64.9	63.5	62.4	61.0	29.7	29.7	64.2	65.2	64.7
Materials	Ϋ́	ΑN	Ϋ́	₹	Ϋ́	Υ	₹	Ϋ́	Ϋ́	Ϋ́	¥	Ϋ́	Ϋ́	¥	Ϋ́	50.9	50.4	48.7	50.3	49.9	52.7
Other	68.1	67.3	9.79	67.8	68.7	65.7	67.3	65.3	63.5	61.1	57.3	54.6	55.0	54.9	53.6	54.6	54.8	57.5	58.9	60.3	61.9
NA = not available																					

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, unpublished tabulations.

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Appendix table 5-8. Federal obligations for academic R&D, by agency: 1971-97

	All agencies	National Institutes of Health	National Science Foundation	Department of Defense	National Aeronautics & Space Administration	Department of Energy ^a	Department of Agriculture	All other agencies
			Millions of co	urrent dollars	1			
1971	1,645	603	267	211	134	94	72	264
1972	1,904	756	362	217	119	85	87	277
1973	1,917	826	374	204	111	83	94	224
1974	2,214	1,108	389	197	99	94	95	232
1975	2,411	1,154	435	203	108	132	108	271
1976	2,552	1,263	437	240	119	145	120	228
1977	2,905	1,399	511	273	118	188	140	276
1978	3,375	1,588	537	383	127	240	186	313
1979	3,889	1,880	617	438	139	260	200	355
1980	4,263	2,012	685	495	158	285	216	412
1981	4,466	2,101	702	573	171	301	243	375
1982	4,605	2,140	715	664	186	277	255	369
1983	4,966	2,392	783	724	189	297	275	306
1984	5,547	2,715	880	830	204	321	261	335
1985	6,340	3,158	1,002	940	237	357	293	352
1986	6,559	3,243	992	1,098	254	345	274	355
1987	7,337	3,903	1,096	1,017	294	386	280	361
1988	7,828	4,199	1,143	1,071	338	406	305	366
1989	8,672	4,565	1,254	1,189	434	454	328	449
1990	9,138	-	1,321	1,213	471		348	505
		4,779 5,501				500		
1991	10,169	5,521	1,436	1,152	534	621	386	520
1992	10,271	5,064	1,540	1,403	586	640	438	600
1993	11,208	5,848	1,562	1,616	614	583	433	553
1994	11,829	6,191	1,680	1,735	641	565	439	577
1995	11,933	6,271	1,734	1,592	708	594	435	599
1996 (est.)	12,251	6,908	1,726	1,380	708	557	423	549
1997 (est.)	12,362	6,987	1,824	1,288	708	574	421	561
		Mil	lions of const	ant 1992 doll	ars ^b			
1971	5,214	1,911	846	669	425	298	228	837
1972	5,758	2,287	1,096	656	360	256	265	838
1973	5,555	2,394	1,085	590	323	240	273	650
1974	5,990	2,997	1,053	534	268	254	256	627
1975	5,914	2,829	1,066	499	265	324	265	666
1976	5,836	2,888	998	550	272	332	274	522
1977	6,179	2,975	1,086	581	250	400	298	588
1978	6,711	3,157	1,068	762	253	477	371	623
		-	•	804		477 477	367	652
1979	7,138	3,452	1,132		255			
1980	7,184	3,390	1,154	835	266	480	365	695
1981	6,854	3,224	1,078	879	263	462	373	576
1982	6,602	3,068	1,025	951	266	397	366	529
1983	6,806	3,277	1,073	992	259	407	377	420
1984	7,320	3,583	1,162	1,095	269	423	344	443
1985	8,086	4,027	1,278	1,199	303	456	374	450
1986	8,136	4,022	1,230	1,362	315	428	339	440
1987	8,847	4,706	1,322	1,226	354	466	337	435
1988	9,122	4,893	1,332	1,248	394	473	355	426
1989	9,696	5,105	1,402	1,329	485	507	367	502
1990	9,806	5,129	1,418	1,302	505	537	374	542
		-						
1991	10,466	5,683	1,478	1,186	549	639	397	535
1992	10,271	5,064	1,540	1,403	586	640	438	600
1993	10,920	5,697	1,522	1,574	598	568	422	539
1994	11,262	5,895	1,600	1,652	611	538	418	549
1995	11,090	5,828	1,611	1,480	658	552	404	557
1996 (est.)	11,130	6,276	1,568	1,253	643	506	384	499
1997 (est.)	10,950	6,189	1,615	1,141	627	509	373	497

Appendix table 5-8. Federal obligations for academic R&D, by agency: 1971-97

	All agencies	National Institutes of Health	National Science Foundation	Department of Defense	National Aeronautics & Space Administration	Department of Energy ^a	Department of Agriculture	All other agencies
			Percentage	s by agency				
1971	100.0	36.7	16.2	12.8	8.1	5.7	4.4	16.0
1972	100.0	39.7	19.0	11.4	6.3	4.4	4.6	14.6
1973	100.0	43.1	19.5	10.6	5.8	4.3	4.9	11.7
1974	100.0	50.0	17.6	8.9	4.5	4.2	4.3	10.5
1975	100.0	47.8	18.0	8.4	4.5	5.5	4.5	11.3
1976	100.0	49.5	17.1	9.4	4.7	5.7	4.7	8.9
1977	100.0	48.2	17.6	9.4	4.0	6.5	4.8	9.5
1978	100.0	47.0	15.9	11.4	3.8	7.1	5.5	9.3
1979	100.0	48.4	15.9	11.3	3.6	6.7	5.1	9.1
1980	100.0	47.2	16.1	11.6	3.7	6.7	5.1	9.7
1981	100.0	47.0	15.7	12.8	3.8	6.7	5.4	8.4
1982	100.0	46.5	15.5	14.4	4.0	6.0	5.5	8.0
1983	100.0	48.2	15.8	14.6	3.8	6.0	5.5	6.2
1984	100.0	49.0	15.9	15.0	3.7	5.8	4.7	6.0
1985	100.0	49.8	15.8	14.8	3.7	5.6	4.6	5.6
1986	100.0	49.4	15.1	16.7	3.9	5.3	4.2	5.4
1987	100.0	53.2	14.9	13.9	4.0	5.3	3.8	4.9
1988	100.0	53.6	14.6	13.7	4.3	5.2	3.9	4.7
1989	100.0	52.6	14.5	13.7	5.0	5.2	3.8	5.2
1990	100.0	52.3	14.5	13.3	5.2	5.5	3.8	5.5
1991	100.0	54.3	14.1	11.3	5.2	6.1	3.8	5.1
1992	100.0	49.3	15.0	13.7	5.7	6.2	4.3	5.8
1993	100.0	52.2	13.9	14.4	5.5	5.2	3.9	4.9
1994	100.0	52.3	14.2	14.7	5.4	4.8	3.7	4.9
1995	100.0	52.6	14.5	13.3	5.9	5.0	3.6	5.0
1996 (est.)	100.0	56.4	14.1	11.3	5.8	4.5	3.5	4.5
1997 (est.)	100.0	56.5	14.8	10.4	5.7	4.6	3.4	4.5

NOTE: Percentages may not total 100 because of rounding.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, Vol. 45, NSF 97-327 (Arlington, VA: 1997); and NSF, annual series.

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^aData for 1974 to 1976 are for the Energy Research and Development Administration; data for 1977 and thereafter are for the U.S. Department of Energy.

bSee appendix table 4-1 for gross domestic product implicit price deflators used to convert current dollars to constant 1992 dollars.

Appendix table 5-9. Federal obligations for academic research, by agency: 1971-97

	All agencies	National Institutes of Health	National Science Foundation	Department of Defense	National Aeronautics & Space Administration	Department of Energy ^a	Department of Agriculture	All other agencies
			Millions of cu	urrent dollars	.			
1971	1,430	551	254	184	70	90	72	209
1972	1,643	677	346	177	48	81	87	226
1973	1,691	749	370	161	80	79	94	158
1974	1,958	1,004	369	167	85	86	94	153
1975	2,079	1,036	420	165	91	112	108	148
1976	2,250	1,138	429	192	98	116	119	158
1977	2,584	1,269	505	221	105	134	139	211
1978	2,928	1,437	534	243	116	175	181	241
1979	3,333	1,657	612	243	125	204	198	266
1980	3,699	1,835	680	313	146	224	214	287
	•	,						
1981	3,920	1,929	698	363	157	248	240	284
1982	4,045	1,995	713	413	156	236	253	280
1983	4,468	2,246	783	472	170	273	273	250
1984	5,030	2,573	880	539	177	311	260	290
1985	5,726	2,990	1,002	587	213	336	292	305
1986	5,883	3,054	992	707	225	334	273	298
1987	6,640	3,651	1,096	681	263	372	279	298
1988	7,023	3,856	1,143	729	310	384	304	297
1989	7,793	4,167	1,254	840	387	437	326	382
1990	8,137	4,349	1,321	795	422	479	346	426
1991	8,868	4,729	1,436	794	474	596	384	456
1992	9,061	4,517	1,540	912	512	605	436	538
1993	9,844	5,204	1,562	1,090	539	547	429	473
1994	10,323	5,517	1,680	1,111	555	529	435	496
1995	10,372	5,481	1,734	1,063	588	558	431	518
1996 (est.)	10,920	6,163	1,726	1,026	588	526	419	472
1997 (est.)	10,823	6,033	1,824	968	588	533	417	461
		Mil	lions of const	ant 1992 doll	ars ^b			
1971	4,532	1,746	805	583	222	285	228	662
1972	4,969	2,048	1,047	535	145	245	263	684
1973	4,902	2,171	1,072	467	232	229	272	458
1974	5,297	2,716	998	452	230	233	254	414
1975	5,098	2,541	1,030	405	223	275	265	363
1976	5,146	2,603	981	439	224	265	272	361
1977	5,495	2,699	1,074	470	223	285	296	449
1978	5,823	2,858	1,062	483	231	348	360	479
1979	6,118	3,042	1,123	497	229	374	363	488
1980	6,233	3,092	1,146	527	246	377	361	484
1981	6,016	2,961	1,071	557	241	381	368	436
1982	5,799	2,860	1,022	592	224	338	363	401
1983	6,123	3,078	1,073	647	233	374	374	343
1984	6,638	3,395	1,161	711	234	410	343	383
1985	7,303	3,814	1,278	749	272	429	372	389
1986	7,298	3,789	1,231	877	279	414	339	370
1987	8,006	3,769 4,402	1,321	821	317	449	336	370 359
1988	8,184	4,494	1,332	850	361	449 447	354	346
1989	8,714	-		939				
	•	4,659 4,667	1,402		433	489 514	365 371	427 457
1990	8,732	4,667	1,418	853	453	514	371	457
1991	9,128	4,867	1,478	817	488	613	395	469
1992	9,061	4,517	1,540	912	512	605	436	538
1993	9,591	5,070	1,522	1,062	525	533	418	461
1994	9,828	5,252	1,599	1,058	528	504	414	472
1995	9,639	5,094	1,611	988	546	519	400	481
1996 (est.)	9,920	5,599	1,568	932	534	478	381	428
1997 (est.)	9,587	5,344	1,615	857	520	472	369	408

Appendix table 5-9. Federal obligations for academic research, by agency: 1971-97

	All agencies	National Institutes of Health	National Science Foundation	Department of Defense	National Aeronautics & Space Administration	Department of Energy ^a	Department of Agriculture	All other agencies
			Percentage	s by agency				
1971	100.0	38.5	17.8	12.9	4.9	6.3	5.0	14.6
1972	100.0	41.2	21.1	10.8	2.9	4.9	5.3	13.8
1973	100.0	44.3	21.9	9.5	4.7	4.7	5.6	9.3
1974	100.0	51.3	18.8	8.5	4.3	4.4	4.8	7.8
1975	100.0	49.8	20.2	7.9	4.4	5.4	5.2	7.1
1976	100.0	50.6	19.1	8.5	4.4	5.2	5.3	7.0
1977	100.0	49.1	19.5	8.6	4.1	5.2	5.4	8.2
1978	100.0	49.1	18.2	8.3	4.0	6.0	6.2	8.2
1979	100.0	49.7	18.4	8.1	3.8	6.1	5.9	8.0
1980	100.0	49.6	18.4	8.5	3.9	6.1	5.8	7.8
1981	100.0	49.2	17.8	9.3	4.0	6.3	6.1	7.2
1982	100.0	49.3	17.6	10.2	3.9	5.8	6.3	6.9
1983	100.0	50.3	17.5	10.6	3.8	6.1	6.1	5.6
1984	100.0	51.2	17.5	10.7	3.5	6.2	5.2	5.8
1985	100.0	52.2	17.5	10.3	3.7	5.9	5.1	5.3
1986	100.0	51.9	16.9	12.0	3.8	5.7	4.6	5.1
1987	100.0	55.0	16.5	10.3	4.0	5.6	4.2	4.5
1988	100.0	54.9	16.3	10.4	4.4	5.5	4.3	4.2
1989	100.0	53.5	16.1	10.8	5.0	5.6	4.2	4.9
1990	100.0	53.4	16.2	9.8	5.2	5.9	4.3	5.2
1991	100.0	53.3	16.2	9.0	5.3	6.7	4.3	5.1
1992	100.0	49.9	17.0	10.1	5.7	6.7	4.8	5.9
1993	100.0	52.9	15.9	11.1	5.5	5.6	4.4	4.8
1994	100.0	53.4	16.3	10.8	5.4	5.1	4.2	4.8
1995	100.0	52.8	16.7	10.2	5.7	5.4	4.2	5.0
1996 (est.)	100.0	56.4	15.8	9.4	5.4	4.8	3.8	4.3
1997 (est.)	100.0	55.7	16.8	8.9	5.4	4.9	3.9	4.3

NOTES: Percentages may not total 100 because of rounding. Academic research includes basic research and applied research.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, Vol. 45, NSF 97-327 (Arlington, VA: 1997); and NSF, annual series.

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^aData for 1974 to 1976 are for the Energy Research and Development Administration; data for 1977 and thereafter are for the U.S. Department of Energy.

bSee appendix table 4-1 for gross domestic product implicit price deflators used to convert current dollars to constant 1992 dollars.

Appendix table 5-10. **Distribution of federal agency academic research obligations, by field: FY 1995** (Percentages)

Field	National Science Foundation	National Aeronautics & Space Administration	Department of Defense	Department of Energy	Department of Health & Human Services	Department of Agriculture
TOTAL SCIENCE & ENGINEERING	100.0	100.0	100.0	100.0	100.0	100.0
Total sciences	77.5	82.3	61.4	85.4	98.6	94.7
Physical sciences	23.1	37.5	13.2	56.8	1.6	5.8
Astronomy	2.8	19.4	0.5	0.0	0.0	0.0
Chemistry	8.4	1.0	5.9	7.7	1.4	5.8
Physics	9.9	11.3	6.7	48.6	0.2	0.0
Other	2.1	5.9	0.1	0.5	0.0	0.0
Mathematics	4.5	0.2	3.8	1.6	0.4	0.1
Computer sciences	5.5	4.8	20.5	8.0	0.3	0.5
Environmental sciences	16.9	25.2	10.6	10.4	0.2	1.0
Atmospheric sciences	5.8	9.5	2.6	5.0	0.0	0.8
Earth sciences	5.9	3.2	2.8	4.3	0.0	0.2
Oceanography	2.9	2.2	4.3	8.0	0.0	0.0
Other	2.3	10.2	1.0	0.3	0.2	0.0
Life sciences	17.0	9.1	10.7	15.1	85.7	75.2
Agricultural sciences	0.0	0.2	0.0	0.0	0.0	35.9
Biology (excluding environmental)	11.9	4.0	2.5	10.1	39.9	20.4
Environmental biology	4.5	0.3	1.9	0.0	0.7	16.8
Medical sciences	0.0	1.6	3.8	4.5	43.0	2.1
Other	0.5	2.9	2.4	0.4	2.1	0.0
Psychology	0.8	0.7	2.0	0.0	4.3	0.0
Biological aspects	0.2	0.0	0.6	0.0	0.0	0.0
Social aspects	0.4	0.4	1.1	0.0	0.0	0.0
Other	0.2	0.3	0.3	0.0	4.3	0.0
Social sciences	4.0	0.1	0.0	0.0	1.5	12.1
Anthropology	0.7	0.0	0.0	0.0	0.0	0.0
Economics	0.7	0.0	0.0	0.0	0.1	10.4
Political science	0.4	0.0	0.0	0.0	0.0	0.0
Sociology	0.4	0.0	0.0	0.0	0.0	1.8
Other	1.8	0.1	0.0	0.0	1.4	0.0
Other sciences	5.8	4.7	0.8	0.8	4.5	0.0
Total engineering	22.5	17.7	38.6	14.6	1.4	5.3
Aeronautical	0.0	5.4	2.0	0.0	0.0	0.0
Astronautical	0.0	2.0	0.6	0.0	0.0	0.0
Chemical	2.4	0.5	0.5	3.6	0.0	0.0
Civil	2.1	0.2	1.0	0.8	0.0	0.0
Electrical	2.5	1.3	11.5	0.5	0.0	0.0
Mechanical	2.9	1.7	6.8	1.5	0.0	0.0
Materials	8.3	3.3	10.7	3.3	0.0	0.0
Other	4.2	3.4	5.6	4.9	1.4	5.3

NOTES: Academic research includes both basic and applied research. The six agencies shown are the only ones that report their research obligations to academia by science and engineering field; they represent approximately 96 percent of academic research obligations.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, Vol. 45, NSF 97-327 (Arlington, VA: 1997); and NSF, annual series.

See figure 5-5.

Appendix table 5-11.

Percentage of federal academic research obligations provided by major agencies, by field: FY 1995

Field	National Science Foundation	National Aeronautics & Space Administration	Department of Defense	Department of Energy	Department of Health & Human Services	Department of Agriculture
TOTAL SCIENCE & ENGINEERING	17.4	5.9	10.7	5.6	56.2	4.3
Total sciences	15.1	5.4	7.4	5.4	62.1	4.6
Physical sciences	33.5	18.5	11.7	26.5	7.7	2.1
Astronomy	28.8	68.0	3.2	0.0	0.0	0.0
Chemistry	40.0	1.6	17.4	11.9	22.3	6.9
Physics	29.0	11.2	12.0	46.0	1.8	0.0
Other	48.5	46.6	1.3	3.6	0.0	0.0
Mathematics	52.6	0.8	26.8	6.0	13.5	0.4
Computer sciences	26.2	7.7	59.7	1.2	4.6	0.5
Environmental sciences	46.5	23.5	17.9	9.2	2.2	0.7
Atmospheric sciences	46.7	26.0	12.6	13.0	0.0	1.6
Earth sciences	58.0	10.8	16.9	13.7	0.0	0.5
Oceanography	44.9	11.4	39.8	3.9	0.0	0.0
Other	31.3	47.8	8.6	1.3	11.1	0.0
Life sciences	5.2	0.9	2.0	1.5	84.7	5.7
Agricultural sciences	0.0	0.8	0.0	0.0	0.0	99.2
Biology (excluding environmental)	7.8	0.9	1.0	2.1	84.8	3.3
Environmental biology	37.2	0.9	9.7	0.0	17.5	34.6
Medical sciences	0.0	0.4	1.6	1.0	96.6	0.4
Other	5.3	9.8	14.9	1.4	68.6	0.0
Psychology	4.9	1.5	7.5	0.0	86.2	0.0
Biological aspects	32.4	0.9	66.5	0.0	0.2	0.0
Social aspects	34.5	10.9	54.4	0.0	0.1	0.0
Other	1.2	0.7	1.1	0.0	97.0	0.0
Social sciences	33.7	0.2	0.0	0.0	40.5	25.6
Anthropology	100.0	0.0	0.0	0.0	0.0	0.0
Economics	20.1	0.0	0.1	0.0	5.2	74.6
Political science	98.5	0.0	0.0	0.0	1.5	0.0
Sociology	41.3	0.0	0.2	0.0	11.7	46.7
Other	28.7	0.4	0.0	0.0	70.9	0.0
Other sciences	25.4	7.1	2.1	1.1	64.3	0.0
Total engineering	35.9	9.5	37.6	7.5	7.4	2.1
Aeronautical	0.0	60.2	39.8	0.0	0.0	0.0
Astronautical	0.0	63.8	36.2	0.0	0.0	0.0
Chemical	60.2	4.3	6.9	28.6	0.0	0.0
Civil	70.0	2.3	19.3	8.4	0.0	0.0
Electrical	24.8	4.2	69.3	1.7	0.0	0.0
Mechanical	36.0	7.1	50.9	6.0	0.0	0.0
Materials	48.9	6.5	38.3	6.2	0.0	0.0
Other	25.7	7.0	21.1	9.7	28.4	8.1

NOTES: Academic research includes both basic and applied research. The six agencies shown are the only ones that report their research obligations to academia by science and engineering field; they represent approximately 96 percent of academic research obligations.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Federal Funds for Research and Development: Fiscal Years 1995, 1996, and 1997, Detailed Statistical Tables, Vol. 45, NSF 97-327 (Arlington, VA: 1997); and NSF, annual series.

See figure 5-6.

Appendix table 5-12. Square footage of total, new construction, and repair/renovation of academic research space, by field: 1986-97 (Thousands of square feet)

Field	1986-87 actual	1988-89 actual	1990-91 actual	1992-93 actual	1994-95 actual	1996-97 actual/ planned
		Total space				
Total, all fields	NA	112,062	116,327	122,015	127,369	136,481
Physical sciences	NA	16,024	16,121	16,353	17,001	17,872
Mathematics	NA	722	790	829	937	1,005
Computer sciences	NA	1.437	1.445	1.606	1.779	2.075
Earth, atmospheric, and ocean sciences	NA	6,313	6,056	6,728	7,053	7,246
Agricultural sciences	NA	17,622	20.821	19.910	20.120	22,118
Biological sciences—universities & colleges	NA	16,072	17,569	17.072	16,982	18.662
Biological sciences—medical schools	NA	7,838	8,584	10,649	10,876	10,797
Medical sciences—universities & colleges	NA	5,320	4,959	6,234	6,070	7,402
Medical sciences—medical schools	NA	14.042	14,762	16,139	16,799	17.727
Psychology	NA NA	3,085	2,978	2,984	3,178	3.404
Social sciences	NA NA	3.337	3,338	3,253	3.403	3.977
Other sciences, not elsewhere classified	NA	4,350	1,846	2,162	2,442	2,363
Engineering	NA	15,900	17,057	18,095	20,730	21,832
		ew construction		18,093	20,730	21,002
Total, all fields	9.922	10.647	11,433	10,992	9,521	10.843
Physical sciences	799	2,000	1,609	1,257	1,551	1,153
•	799 9	2,000 25	46	1,237	1,551	72
Mathematics	237		293	172	-	121
Computer sciences		286			143	
Earth, atmospheric, and ocean sciences	380	324	529	502	282	746
Agricultural sciences	1,513	1,146	955	1,218	808	1,051
Biological sciences—universities & colleges	1,275	1,549	1,374	1,169	1,028	1,804
Biological sciences—medical schools	433	712	1,426	1,020	579	465
Medical sciences—universities & colleges	613	306	673	669	388	926
Medical sciences—medical schools	1,335	1,948	2,288	3,154	1,694	2,049
Psychology	132	115	164	78	145	82
Social sciences	202	329	*	221	380	176
Other sciences, not elsewhere classified	603	418	380	420	340	77
Engineering	2,390	1,490	1,697	1,065	2,174	2,122
	Repai	red/renovated	space			
Total, all fields	13,431	11,449	8,606	9,134	13,122	13,698
Physical sciences	1,746	1,928	1,680	1,725	2,474	1,991
Mathematics	37	136	39	11	67	95
Computer sciences	193	144	164	54	124	142
Earth, atmospheric, and ocean sciences	362	930	450	418	521	570
Agricultural sciences	628	530	391	335	1,245	661
Biological sciences—universities & colleges	2,555	2,203	1,055	1,304	1,610	1,777
Biological sciences—medical schools	1,056	1,259	1,301	864	752	1,380
Medical sciences—universities & colleges	737	705	627	284	757	773
Medical sciences—medical schools	2,499	1,598	1,443	1,678	3,129	3,058
Psychology	256	88	254	141	182	272
Social sciences	181	119	*	236	296	346
Other sciences, not elsewhere classified	465	180	42	152	162	162
Engineering	2,716	1.630	1.159	1.932	1.803	2.410

NA = not available; * = data included with psychology

NOTES: Data for two years are combined—e.g., 1988-89 refers to two fiscal years. In the 1986-87 period, data were not reported for total R&D space. Square footage refers to net assignable square feet. Total space is actual space reported. New construction and repair/renovation for 1996-97 are planned rather than actual space. Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Scientific and Engineering Research Facilities at Universities and Colleges: 1996, NSF 96-326 (Arlington, VA: 1996).

Appendix table 5-13. Cost of academic research new construction and repair/renovation projects, by field: 1986-97

		Total cost i	n millions of	n millions of constant 1995 dollars ^a	5 dollars ^a			Cost per so	luare foot in	Cost per square foot in constant 1995 dollars	95 dollars	
Field	1986-87 actual	1988-89 actual	1990-91 actual	1992-93 actual	1994-95 actual	1996-97 planned	1986-87 actual	1988-89 actual	1990-91 actual	1992-93 actual	1994-95 actual	1996-97 planned
				New	New construction	uc						
Total, all fields	2,570	2,874	3,353	3,040	2,768	3,072	259	270	293	277	291	283
Physical sciences	228	468	484	364	426	390	285	234	301	290	275	338
Mathematics	2	10	4	=	2	25	222	400	304	250	250	347
Computer sciences	77	92	45	51	46	31	325	266	154	297	322	256
ocean sciences	71	95	191	133	33	240	187	293	361	265	117	322
Agricultural sciences	188	177	197	227	150	212	124	154	206	186	186	202
Biological sciences—U&C	406	462	508	316	388	202	318	298	370	270	377	281
Biological sciences-MS	174	211	429	369	226	214	402	296	301	362	390	460
Medical sciences—U&C	254	71	170	173	122	243	414	232	253	259	314	262
Medical sciences-MS	378	684	738	206	525	672	283	351	323	288	310	328
Psychology	29	29	4	17	42	38	220	252	250	218	290	463
Social sciences	48	26	*	48	112	54	238	170	*	217	295	307
Other sciences, n.e.c	174	82	06	11	122	16	289	196	237	264	359	208
Engineering	538	453	445	309	275	429	225	304	262	290	264	202
				Repa	Repair/renovation	uo						
Total, all fields	1,050	1,178	931	905	1,058	1,258	78	103	108	66	81	92
Physical sciences	132	192	170	145	192	241	92	100	101	84	78	121
Mathematics	2	13	9	2	9	-	135	96	154	182	06	11
Computer sciences	22	=	24	4	80	13	114	92	146	74	65	92
Earth, atmospheric, and												
ocean sciences	26	21	18	34	35	41	72	23	40	81	29	72
Agricultural sciences	25	27	39	15	72	48	40	51	100	45	28	73
Biological sciences—U&C	183	147	152	117	127	187	72	29	144	06	62	105
Biological sciences-MS	26	88	138	125	101	175	92	71	106	145	134	127
Medical sciences—U&C	65	28	29	30	29	92	88	40	94	106	78	84
Medical sciences-MS	218	188	187	253	226	132	87	118	130	151	72	43
Psychology	17	13	35	Ξ	28	29	99	148	138	78	154	107
Social sciences	45	10	*	7	40	09	249	84	*	47	135	173
Other sciences, n.e.c	38	19	9	∞	12	42	82	106	143	53	74	259
Engineering	176	422	95	150	150	222	65	259	79	78	83	95
* = data included with psychology: n e.g. = pot elsewhere classified: 118	not elsewhere	classified: U80	C = universities	= Iniversities and colleges: MS = medical schools	MS = medica	sloodos						

= data included with psychology; n.e.c. = not elsewhere classified; U&C = universities and colleges; MS = medical schools

NOTES: Data for two years are combined—e.g., 1988-89 refers to two fiscal years. Square foot refers to net assignable square feet. Current dollars have been adjusted to 1995 constant dollars using the Bureau of Census's Composite Fixed-Weighted Price Index for Construction.

^aProject cost estimates are prorated to reflect R&D component only.

SOURCE: National Science Foundation, Science Resources Studies Division, Scientific and Engineering Research Facilities at Universities and Colleges: 1996, NSF 96-326 (Arlington, VA: 1996).

Appendix table 5-14. Funds for new construction and repair/renovation of S&E research space, by type of institution and funding source: 1986-95

		Millio	Millions of current dollars	ollars				Percent of funds	ø	
Institution type and funding source	1986-87	1988-89	1990-91	1992-93	1994-95	1986-87	1988-89	1990-91	1992-93	1994-95
			New constru	New construction and repair/renovation	ir/renovation					
Total, all institutions	2,888.5	3,474.0	3,801.3	3,646.9	3,825.6	100.0	100.0	100.0	100.0	100.0
Federal Government	172.7	413.1	525.3	515.4	317.1	0.9	11.9	13.8	14.1	8.3
State and local government	1,012.2	1,124.5	1,199.6	1,220.7	1,446.5	35.0	32.4	31.6	33.5	37.8
Private donations	588.5	511.3	453.2	373.4	470.8	20.4	14.7	11.9	10.2	12.3
Institutional funds	617.8	914.6	749.5	705.1	874.6	21.4	26.3	19.7	19.3	22.9
Tax-exempt bonds	450.7	390.1	793.9	700.5	476.6	15.6	11.2	20.9	19.2	12.5
Other debt	6.9	111.8	43.4	65.7	224.3	0.2	3.2	. .	1.8	5.9
Other	39.3	0.9	36.3	62.9	15.8	4.1	0.2	1.0	1.8	0.4
Total, public institutions	1,790.7	2,425.5	2,469.3	2,536.8	2,368.1	100.0	100.0	100.0	100.0	100.0
Federal Government	53.5	305.7	412.7	360.1	154.3	3.0	12.6	16.7	14.2	6.5
State and local government	981.1	1,067.7	1,042.9	1,166.9	1,419.0	54.8	44.0	42.2	46.0	59.9
Private donations	274.1	214.9	182.9	177.4	139.9	15.3	8.9	7.4	7.0	5.9
Institutional funds	264.3	659.8	404.8	352.7	303.2	14.8	27.2	16.4	13.9	12.8
Tax-exempt bonds	215.0	161.1	410.7	446.4	324.4	12.0	9.9	16.6	17.6	13.7
Other debt	2.7	13.0	7.8	17.8	14.4	0.2	0.5	0.3	0.7	9.0
Other	4.0	9.0	7.5	15.2	13.0	0.0	0.0	0.3	9.0	0.5
Total, private institutions	1,097.8	1,048.5	1,332.0	1,110.1	1,457.5	100.0	100.0	100.0	100.0	100.0
Federal Government	119.2	107.4	112.6	155.3	162.8	10.9	10.2	8.5	14.0	11.2
State and local government	31.1	56.8	156.7	53.8	27.5	2.8	5.4	11.8	4.8	1.9
Private donations	314.4	296.4	270.3	196.0	330.9	28.6	28.3	20.3	17.7	22.7
Institutional funds	353.5	254.8	344.7	352.4	571.4	32.2	24.3	25.9	31.7	39.2
Tax-exempt bonds	235.7	229.0	383.2	254.1	152.2	21.5	21.8	28.8	22.9	10.4
Other debt	4.2	98.8	35.6	47.9	209.9	4.0	9.4	2.7	4.3	14.4
Other	38.9	5.4	28.8	20.7	2.8	3.5	0.5	2.2	4.6	0.2
			ž	New construction	u					
Total, all institutions	2,050.6	2,464.5	2,975.6	2,811.9	2,767.5	100.0	100.0	100.0	100.0	100.0
Federal Government	145.4	352.0	476.3	459.3	206.4	7.1	14.3	16.0	16.3	7.5
State and local government	779.1	890.7	926.6	9.896	1,180.9	38.0	36.1	32.1	34.4	42.7
Private donations	487.5	459.2	352.6	301.0	360.0	23.8	18.6	11.8	10.7	13.0
Institutional funds	289.8	343.8	394.1	374.4	441.9	14.1	14.0	13.2	13.3	16.0
Tax-exempt bonds	313.1	320.2	727.5	620.1	426.1	15.3	13.0	24.4	22.1	15.4
Other debt	3.1	95.9	35.4	38.9	145.7	0.2	3.9	1.2	4.	5.3
Other	31.9	0.8	33.1	49.7	6.5	1.6	0.0	1.1	9. 0	0.2
Iotal, public institutions	1,354.8	0.727,1	2,020.0	2,016.4	1,872.3	0.001	0.001	0.001	0.001	0.001
Federal Government	40.3	274.3	388.1	325.8	115.4	0. i	15.9	19.2	16.2	6.2
State and local government	754.5	838.4	809.4	929.8	1,164.6	55.7	48.5	40.1	46.1	62.2
Private donations	259.1	192.9	139.1	152.5	123.9	19.1	11.2	6.9	7.6	9.9
Institutional funds	109.2	256.3	270.2	198.3	142.4	8.1	14.8	13.4	8.6	9.7
Tax-exempt bonds	189.5	154.5	398.6	390.5	306.1	14.0	8.9	19.7	19.4	16.3
Other debt	2.4	8.1	7.8	16.2	13.5	0.2	0.5	0.4	0.8	0.7
Other	0.2	9.0	6.9	3.3	6.5	0.0	0:0	0.3	0.2	0.3

Appendix table 5-14. Funds for new construction and repair/renovation of S&E research space, by type of institution and funding source: 1986-95

		Millior	Millions of current dollars	ollars			۵	Percent of funds		
Institution type and funding source	1986-87	1988-89	1990-91	1992-93	1994-95	1986-87	1988-89	1990-91	1992-93	1994-95
Total, private institutions	8.269	737.5	922.6	795.5	895.2	100.0	100.0	100.0	100.0	100.0
Federal Government	105.1	77.7	88.2	133.5	91.0	15.1	10.5	9.5	16.8	10.2
State and local government	24.6	52.3	147.2	38.8	16.3	3.5	7.1	15.4	4.9	1.8
Private donations	228.4	266.3	213.5	148.5	236.1	32.8	36.1	22.3	18.7	26.4
Institutional funds	180.6	87.5	123.9	176.1	299.5	26.0	11.9	13.0	22.1	33.5
Tax-exempt bonds	123.6	165.7	328.9	229.6	120.0	17.8	22.5	34.4	28.9	13.4
Other debt	0.7	87.8	27.6	22.7	132.2	0.1	11.9	2.9	2.9	14.8
Other	31.7	0.2	26.2	46.4	0.0	4.6	0.0	2.7	5.8	0.0
			Re	Repair/renovation	E					
Total, all institutions	1,837.9	009.5	825.7	835.0	1,058.1	100.0	100.0	100.0	100.0	100.0
Federal Government	27.3	61.1	49.0	56.1	110.7	3.3	6.1	5.9	6.7	10.5
State and local government	233.1	233.8	243.0	252.1	265.6	27.8	23.2	29.4	30.2	25.1
Private donations	101.0	52.1	100.6	72.4	110.8	12.1	5.2	12.2	8.7	10.5
Institutional funds	328.0	570.8	355.4	330.7	432.7	39.1	56.5	43.0	39.6	40.9
Tax-exempt bonds	137.6	6.69	66.4	80.4	50.5	16.4	6.9	8.0	9.6	4.8
Other debt	3.8	15.9	8.0	26.8	78.6	0.5	1.6	1.0	3.2	7.4
Other	7.4	5.2	3.2	16.2	9.3	6.0	0.5	0.4	1.9	6.0
Total, public institutions	435.9	698.5	449.3	520.4	495.8	100.0	100.0	100.0	100.0	100.0
Federal Government	13.2	31.4	24.6	34.3	38.9	3.0	4.5	5.5	9.9	7.8
State and local government	226.6	229.3	233.5	237.1	254.4	52.0	32.8	52.0	45.6	51.3
Private donations	15.0	22.0	43.8	24.9	16.0	3.4	3.1	9.7	4.8	3.2
Institutional funds	155.1	403.5	134.6	154.4	160.8	35.6	57.8	30.0	29.7	32.4
Tax-exempt bonds	25.5	9.9	12.1	55.9	18.3	5.8	6.0	2.7	10.7	3.7
Other debt	0.3	4.9	0.0	1.6	6.0	0.1	0.7	0.0	0.3	0.2
Other	0.2	0.0	9.0	11.9	6.5	0.0	0.0	0.1	2.3	1.3
Total, private institutions	402.0	311.0	376.4	314.6	562.3	100.0	100.0	100.0	100.0	100.0
Federal Government	14.1	29.7	24.4	21.8	71.8	3.5	9.6	6.5	6.9	12.8
State and local government	6.5	4.5	9.5	15.0	11.2	1.6	1.4	2.5	4.8	2.0
Private donations	86.0	30.1	56.8	47.5	94.8	21.4	2.6	15.1	15.1	16.9
Institutional funds	172.9	167.3	220.8	176.3	271.9	43.0	53.8	28.7	26.0	48.4
Tax-exempt bonds	112.1	63.3	54.3	24.5	32.2	27.9	20.4	14.4	7.8	2.7
Other debt	3.5	11.0	8.0	25.2	7.77	6.0	3.5	2.1	8.0	13.8
Other	7.2	5.2	2.6	4.3	2.8	1.8	1.7	0.7	4.1	0.5
NOTES: Data for two washing on a secondary	1000 00 2001	oyooy loogit owt	Potoile may not	204 01040+ 04 1010	aileanier fo come					

NOTES: Data for two years are combined – e.g., 1988-89 refers to two fiscal years. Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Scientific and Engineering Research Facilities at Universities and Colleges: 1996, NSF 96-326 (Arlington, VA: 1996).

See figure 5-7.

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Science & Engineering Indicators – 1998

Appendix table 5-15. **Total stock of S&E research space, by condition and field: 1988-96**(Percentages)

		Su in mc sophis	Suitable for use in most scientifically ophisticated researc	Suitable for use in most scientifically sophisticated research	_	<u> </u>	fective 1 not mo sophist	fective for most uses, t not most scientifically sophisticated research	Effective for most uses, but not most scientifically sophisticated research	t		Requ repair to be us	Requires limited repair/renovation to be used effectively	ted tion tively		¥	Requestives to the second to t	Requires major repair/renovation to be used effectively ^a	jor tion tively ^a		rep.	Requires replacement ^b	<u>ئ</u>
Field	1988	1990	1992	1988 1990 1992 1994 1996	1996	1988	1990	1992	1994	1996	1988	1990	1992	1994	1996	1988	1990	1992	1994	1996	1992	1994	1996
Physical sciences	25.7	26.3	29.9	24.8		34.5	33.5	32.5	33.8	NA	22.3	23.7	23.0	23.8	48.3	17.5	16.5	12.5	15.3	AA	2.1	2.3	18.8
Mathematics	29.5	25.9	30.6	22.6	42.9	45.3	44.6	47.1	47.0	Ν	19.4	21.9	17.5	24.9	46.8	5.8	9.7	3.0	4.1	Ϋ́	4.8	1.3	6.6
Computer sciences	32.6	38.3	43.9	35.2	55.0	35.0	35.5	35.4	40.9	Α	16.2	18.0	13.7	17.9	37.1	16.2	8.1	0.9	4.7	Ϋ́	1.0	1.2	7.5
Environmental sciences	18.7	18.7	22.5	22.1	32.4	40.6	40.4	41.9	35.9	ΑN	26.0	26.1	23.7	22.9	48.1	14.7	14.8	9.2	13.0	Α	2.4	0.9	19.1
Agricultural sciences	21.2	20.3	16.8	18.2	30.2	32.5	33.6	34.3	32.0	ΑĀ	26.2	24.1	22.7	27.4	46.2	20.0	22.0	18.5	13.6	ΑN	7.7	8.8	23.5
Biological sciences—																							
universities and colleges	23.2	27.5	25.5	22.6	37.9	36.2	34.3	32.6	31.0	ΑN	25.0	24.2	26.7	27.1	43.8	15.5	14.0	12.5	14.2	ΑN	2.8	2.0	17.8
Biological sciences—																							
medical schools	36.2	34.3	38.6	36.9	45.1	34.0	33.5	30.2	32.2	ΑN	16.5	18.9	17.4	15.8	40.1	13.4	13.2	12.5	13.3	ΝΑ	4.	. 8.	14.7
Medical sciences—																							
universities and colleges	18.1	24.0	24.0 24.4	25.7	35.2	40.1	35.1	34.4	34.4	ΑN	27.2	23.8	24.0	23.3	43.6	14.6	17.0	13.8	11.8	ΑN	3.4	4.7	20.6
Medical sciences—																							
medical schools	25.2	28.4	29.7	33.7	44.3	35.1	34.4	33.3	29.1	Ν	23.1	23.7	22.3	20.5	36.0	16.6	13.4	12.6	13.5	Α	5.0	3.3	19.7
Psychology	23.2	20.5	22.2	22.8	38.2	43.7	46.6	46.9	37.9	ΑN	20.8	21.4	20.9	26.1	48.7	12.3	11.6	9.0	1.1	ΑN	1.0	2.0	12.3
Social sciences	14.8	17.2	17.1	14.4	31.8	47.7	45.0	45.8	46.2	Ν	26.7	28.1	26.7	28.2	54.2	10.8	8.6	12.2	9.0	Ϋ́	1.2	6.1	13.1
Engineering	26.1	27.9	28.4	31.4	38.2	37.6	35.6	36.1	32.3	ΑN	22.4	22.0	22.2	21.3	43.3	13.9	14.5	10.8	12.1	ΑN	2.4	2.8	17.9

NA = not available

NOTES: Percentage of total is calculated within each field according to the condition of the research space. In 1996, the survey response categories were changed to "suitable for the most scientifically competitive research"; "effective for most levels of research, but may need limited repair/renovation"; and "requires major renovation or replacement to be used effectively."

The data for 1988 and 1990 in this category include space requiring replacement.

^bThis category was first used in the 1992 survey.

SOURCE: National Science Foundation, Science Resources Studies Division, Scientific and Engineering Research Facilities at Universities and Colleges 1996, NSF 96-326 (Arlington, VA: 1996).

Science & Engineering Indicators – 1998

See text table 5-2.

Appendix table 5-16. Adequacy of the amount of S&E research space, by field: 1988-96

									ш	ercenta	ge of ins	Percentage of institutions reporting that their	s report.	ng that	their sp	space is:				
	ĭ	Total num	number of ir	of institutions	SL		٩	Adequate	an .			Genera	Generally adequate	uate			lı	Inadequate	on.	
Field	1988	1988 1990	1992	1994	1996	1988	1990	1992	1994	1996	1988	. 0661	1992	1994 1	1 966	886	1990	1992	1994	1996
Physical sciences	445	450	433	489	490	4.7	8.7	10.6	6.4	44.9	52.4	50.8	52.3	53.1	NA N	42.9	40.5	37.0	40.5	54.5
Mathematical sciences	318	296	300	348	343	21.0	17.6	16.1	16.0	68.4	53.6	47.2	58.6	55.5	NA	25.4	35.2	25.3	28.3	30.3
Computer sciences	331	280	297	347	340	15.1	13.5	12.9	15.5	54.6	38.2	41.5	26.7	48.3	NA V	46.9	45.0	30.3	36.0	43.7
Environmental sciences	297	284	314	310	306	11.0	1.1	10.5	7.2	53.7	49.4	48.4	59.4	59.6	N A	39.5	40.5	30.1	33.2	46.0
Agricultural sciences	96	94	96	123	112	11.0	17.0	17.5	10.5	48.1	51.2	39.9	48.2	59.7	NA	37.7	43.1	34.3	29.6	51.9
Biological sciences—universities and colleges	444	451	434	490	504	8.3	8.7	10.8	6.2	45.9	45.8	48.2	51.8	53.7	NA V	45.9	43.1	37.4	40.1	53.3
Biological sciences – medical schools	91	105	125	132	116	3.7	10.4	3.6	10.6	55.9	47.3	35.5	60.5	53.5	NA V	49.0	54.1	35.9	35.5	45.5
Medical sciences—universities and colleges	191	189	210	243	239	14.3	13.0	14.2	11.7	42.6	46.0	40.3	50.1	50.3	NA	39.7	46.7	35.7	38.2	57.4
Medical sciences-medical schools	134	141	146	126	118	0.8	7.0	4.2	10.8	34.1	52.6	33.8	54.1	44.8	NA V	46.6	59.2	41.8	44.0	62.9
Psychology	403	398	388	425	430	16.8	13.2	17.2	14.8	55.4	51.4	54.3	20.0	53.9	NA	31.8	32.4	32.9	31.2	43.8
Social sciences	360	345	328	378	378	12.9	12.7	8.2	7.2	51.2	50.2	51.0	64.4	63.4	NA	36.9	36.2	27.4	29.3	47.6
Other sciences	06	69	7	63	8	10.4	16.9	14.0	15.0	51.8	51.3	39.2	44.9	50.0	NA	38.4	44.0	41.1	36.5	40.7
Engineering	283	296	290	297	288	8.7	10.6	2.8	6.7	42.8	40.1	40.8	49.1	53.3	NA	51.1	48.6	45.1	40.5	57.2

NA = not available

NOTE: The 1996 survey question included only three categories: adequate; inadequate, including insufficient; or not applicable or not needed. In previous years, the survey included five categories: adequate, generally adequate, inadequate, nonexistent but needed, or not applicable or not needed.

SOURCE: National Science Foundation, Science Resources Studies Division, Scientific and Engineering Research Facilities at Universities and Colleges: 1996, NSF 96-326 (Arlington, VA: 1996).

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Appendix table 5-17. Expenditures for deferred S&E research facility construction and repair/renovation needs, by field: 1996 (Millions of current dollars)

		Total, all needs		In a plan ^a	ılanª	Not in a plan ^a	planª
Field	Construction & repair/renovation	Construction	Repair/ renovation	Construction	Repair/ renovation	Construction	Repair/ renovation
Total science & engineering	9,341	5,675	3,666	4,629	2,790	1,046	876
Physical sciences	1,857	1,175	682	1,065	287	110	92
Mathematics	123	29	64	26	53	က	=
Computer sciences	153	120	33	86	22	33	7
Environmental sciences	299	473	193	377	166	96	28
Agricultural sciences	808	516	292	356	145	160	148
Biological sciences—universities & colleges	1,445	790	656	639	208	151	148
Biological sciences – medical schools	374	200	174	166	102	34	72
Medical sciences—universities & colleges	518	328	190	238	114	06	9/
Medical sciences - medical schools	1,261	792	494	099	404	107	06
Psychology	135	84	51	55	41	29	10
Social sciences	306	185	121	142	64	43	22
Other sciences	168	71	97	09	25	11	40
Engineering	1,523	206	616	727	525	180	91

^aThis refers to whether the deferred need is included (or not included) in a formal institutional plan.

SOURCE: National Science Foundation, Science Resources Studies Division, Scientific and Engineering Research Facilities at Universities and Colleges: 1996, NSF 96-326 (Arlington, VA: 1996).

Appendix table 5-18. Current fund expenditures for research equipment at academic institutions, by field: 1985-95

Field	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
			Millions	Millions of current dollars	dollars						
Total expenditures											
Total science & engineering	671.6	782.9	837.0	912.0	986.1	1,012.2	1,023.9	1,032.2	1,038.5	1,100.7	1,235.3
Physical sciences	141.8	162.9	166.2	181.4	180.8	191.1	189.4	198.1	207.0	206.5	237.8
Mathematics	0.9	6.8	9.8	9.7	10.3	10.2	10.6	10.3	15.1	14.8	15.3
Computer sciences	35.5	42.6	42.8	42.7	43.0	48.0	58.5	45.0	53.4	58.7	77.0
Environmental sciences	47.8	51.3	55.4	55.8	67.5	72.1	70.0	77.5	76.4	82.9	81.2
Life sciences	282.6	330.6	335.3	379.4	431.0	419.9	411.3	429.0	416.7	435.5	464.1
Psychology	8.7	8.7	10.6	9.6	10.6	10.7	11.1	11.1	15.4	12.6	12.1
Social sciences	10.1	14.1	11.8	11.9	14.5	15.0	14.0	17.9	18.9	21.2	26.4
Other sciences	14.7	20.1	26.8	25.9	26.5	25.1	25.2	18.5	18.1	22.0	31.2
Engineering	124.4	145.9	178.3	195.5	201.9	220.0	233.8	224.7	217.4	246.5	290.2
Federal expenditures											
Total science & engineering	432.3	501.3	526.4	576.5	595.4	0.909	610.3	617.2	632.9	664.5	723.5
Physical sciences	113.2	130.5	130.5	142.8	133.2	144.0	139.3	151.5	153.6	151.0	175.8
Mathematics	4.9	5.2	7.6	7.6	6.9	6.7	6.7	7.0	11.3	10.6	9.0
Computer sciences	29.4	35.1	33.9	34.7	30.9	31.6	43.6	29.6	37.4	40.3	47.8
Environmental sciences	32.3	35.0	35.9	36.7	44.6	47.5	42.9	52.0	53.9	59.9	55.5
Life sciences	157.1	188.4	187.8	215.0	237.8	223.3	220.5	230.5	226.2	227.3	225.7
Psychology	6.2	5.9	8.1	6.5	6.9	6.8	7.1	7.1	10.6	7.7	7.7
Social sciences	4.0	4.3	3.5	3.3	4.9	4.9	5.1	7.7	9.7	8.7	10.5
Other sciences	6.8	11.7	13.7	12.1	13.2	11.5	9.6	5.2	7.5	9.6	8.6
Engineering	78.3	85.2	105.3	117.8	117.0	129.6	135.4	126.6	127.8	149.4	181.7
Nonfederal expenditures											
Total science & engineering	239.3	281.6	310.6	335.5	390.7	406.2	413.6	415.0	402.6	436.2	511.8
Physical sciences	28.6	32.4	35.7	38.7	47.6	47.1	50.1	46.6	53.4	55.5	62.0
Mathematics	1.1	1.6	2.2	2.1	3.3	3.5	3.9	3.3	3.8	4.1	6.3
Computer sciences	0.9	7.5	8.9	8.0	12.1	16.4	14.8	15.4	16.1	18.4	29.2
Environmental sciences	15.5	16.3	19.4	19.1	22.9	24.7	27.1	25.6	22.5	23.0	25.7
Life sciences	125.5	142.2	147.5	164.4	193.2	196.6	190.9	198.6	190.5	208.2	238.5
Psychology	2.5	2.8	2.5	3.0	3.7	3.9	4.0	4.1	4.8	5.0	4.4
Social sciences	0.9	8.6	8.3	8.6	9.6	10.1	8.9	10.1	11.3	12.5	15.9
Other sciences	7.9	8.3	13.1	13.9	13.3	13.5	15.6	13.2	10.6	12.5	21.4
Engineering	46.1	2.09	73.0	7.77	84.9	90.3	98.4	98.1	9.68	97.1	108.4

1995

1994

1993

1992

1991

1990

1989

1988

1987

1986

1985

Field

Appendix table 5-18. Current fund expenditures for research equipment at academic institutions, by field: 1985-95

					= -						
			Millions of C	Millions of constant 1992 dollars	32 dollars						
Total expenditures											
Total science & engineering	856.6	971.2	1,009.2	1,062.7	1,102.6	1,086.2	1,053.9	1,032.2	1,011.7	1,047.9	1,148.1
Physical sciences	180.9	202.1	200.4	211.4	202.2	205.1	195.0	198.1	201.7	196.6	221.0
Mathematics	7.7	8.5	11.8	11.3	11.5	11.0	10.9	10.3	14.7	14.1	14.3
Computer sciences	45.2	52.8	51.6	49.8	48.1	51.5	60.2	45.0	52.1	55.9	71.6
Environmental sciences	61.0	63.6	2.99	65.0	75.4	77.4	72.0	77.5	74.4	79.0	75.5
Life sciences	360.4	410.1	404.3	442.2	481.9	450.6	423.3	429.0	406.0	414.6	431.3
Psychology	11.1	10.7	12.7	11.2	11.9	11.5	11.4	11.1	15.0	12.0	11.2
Social sciences	12.9	17.5	14.2	13.8	16.2	16.1	14.4	17.9	18.4	20.2	24.6
Other sciences	18.8	24.9	32.4	30.2	29.6	26.9	25.9	18.5	17.7	21.0	29.0
Engineering	158.7	181.0	215.0	227.8	225.8	236.1	240.6	224.7	211.8	234.7	269.7
Federal expenditures											
Total science & engineering	551.4	621.9	634.7	671.8	665.7	650.4	628.2	617.2	619.5	632.7	672.4
Physical sciences	144.4	161.9	157.4	166.4	148.9	154.5	143.4	151.5	149.6	143.8	163.4
Mathematics	6.3	6.4	9.5	8.8	7.8	7.2	6.9	7.0	11.1	10.1	8.4
Computer sciences	37.5	43.6	40.9	40.5	34.6	33.9	44.9	29.6	36.4	38.4	44.4
Environmental sciences	41.2	43.4	43.3	42.7	49.9	51.0	44.2	52.0	52.5	57.0	51.6
Life sciences	200.4	233.8	226.5	250.6	265.9	239.7	226.9	230.5	220.4	216.4	209.7
Psychology	7.9	7.3	8.6	7.6	7.8	7.3	7.3	7.1	10.3	7.3	7.2
Social sciences	5.1	5.3	4.2	3.9	5.4	5.2	5.3	7.7	7.4	8.3	9.8
Other sciences	8.7	14.5	16.5	14.1	14.7	12.4	6.6	5.2	7.3	9.1	9.1
Engineering	6.66	105.7	127.0	137.3	130.8	139.1	139.4	126.6	124.5	142.2	168.9
Nonfederal expenditures											
Total science & engineering	305.2	349.3	374.5	391.0	436.9	435.9	425.7	415.0	392.2	415.3	475.6
Physical sciences	36.5	40.2	43.0	45.1	53.2	9.09	51.6	46.6	52.1	52.8	9.75
Mathematics	1.4	2.0	2.6	2.5	3.7	3.7	4.1	3.3	3.7	3.9	5.9
Computer sciences	7.7	9.3	10.7	9.3	13.5	17.6	15.3	15.4	15.7	17.5	27.2
Environmental sciences	19.7	20.2	23.4	22.3	25.6	26.5	27.9	25.6	21.9	21.9	23.9
Life sciences	160.1	176.3	177.9	191.6	216.0	211.0	196.4	198.6	185.6	198.2	221.6
Psychology	3.2	3.5	3.0	3.5	4.1	4.2	4.1	4.1	4.7	4.7	4.1
Social sciences	7.7	12.2	10.1	10.0	10.8	10.9	9.1	10.1	11.0	11.9	14.8
Other sciences	10.1	10.4	15.8	16.2	14.9	14.5	16.0	13.2	10.4	11.9	19.9
Engineering	58.8	75.3	88.0	90.5	95.0	6.96	101.2	98.1	87.3	92.5	100.8

*See appendix table 4-1 for gross domestic product implicit price deflators used to convert current dollars into constant 1992 dollars.

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, annual series.

See figure 5-9.

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Appendix table 5-19.

Current fund expenditures for research equipment at academic institutions as a percentage of total academic R&D expenditures, by field: 1985-95 (Percentages)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total science & engineering	6.9	7.2	6.9	6.8	9.9	6.2	5.8	5.5	5.2	5.2	5.6
Physical sciences	12.4	12.7	11.9	11.7	11.0	10.6	9.8	9.6	9.7	9.5	10.6
Mathematics	4.7	4.5	5.5	4.9	4.8	4.6	4.6	4.1	5.6	5.2	5.4
Computer sciences	12.6	13.3	11.5	10.5	9.1	9.3	10.5	8.1	8.8	9.0	11.3
Environmental sciences	8.9	9.9	9.9	6.2	6.7	6.8	6.3	6.3	5.8	5.9	5.7
Life sciences	5.4	5.6	5.1	5.2	5.3	4.8	4.3	4.2	3.8	3.8	3.8
Psychology	5.5	5.1	5.6	4.5	4.6	4.2	3.9	3.4	4.4	3.5	3.3
Social sciences	5.6	3.0	2.4	2.1	2.3	2.1	1.9	2.2	2.1	2.2	2.6
Other sciences	7.9	8.8	10.5	0.6	8.3	7.5	7.6	5.9	4.9	5.8	7.9
Engineering	8.8	8.9	9.4	9.3	8.4	8.3	8.0	7.3	6.9	7.4	8.2

SOURCES: National Science Foundation (NSF), Science Resources Studies Division, Academic Science and Engineering R&D Expenditures: Fiscal Year 1995, Detailed Statistical Tables, forthcoming (Arlington, VA: 1998); and NSF, annual series.

Appendix table 5-20. Number and percentage of academic research instruments, by field, price range, and type: 1993

	All insti	All instruments	Computers and data handling instruments	Computers and data handling instruments	Chromatographs and spectrometers	aphs and neters	Microscopy instruments	copy	Bioanalytical instruments	lytical nents	Other instruments	truments
Field	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
					All systems							
Total	61,684	100	12,023	100	13,789	100	5,597	100	10,205	100	20,071	100
Engineering	18,051	59	4,137	34	2,723	20	801	4	273	က	10,117	20
Chemistry	6,787	1	817	7	4,003	29	180	က	32	*	1,755	6
Physics/astronomy	6,415	10	1,443	12	1,159	80	212	4	303	က	3,299	16
Environmental sciences	5,126	ω	1,455	12	1,740	13	554	10	142	-	1,234	9
Computer sciences	2,110	ო	1,812	15	0	0	0	0	0	0	298	-
Academic departments	1,426	8	1,174	10	0	0	0	0	0	0	252	_
Computer facilities	684	-	638	2	0	0	0	0	0	0	46	*
Agricultural sciences	615	-	29	-	227	2	27	*	172	2	122	-
Biological sciences	20,978	34	2,126	18	3,797	28	3,611	92	9,217	06	2,227	Ξ
Other, multidisciplinary	1,603	ო	167	-	140	-	211	4	99	-	1,019	2
				Systems co	Systems costing \$20,000 - \$999,999	- \$999,999						
Total	61,348	100	11,892	100	13,730	100	5,579	100	10,205	100	19,943	100
Engineering	17,996	59	4,135	35	2,696	20	800	4	273	က	10,091	51
Chemistry	6,771	1	815	7	3,999	59	180	က	32	*	1,744	6
Physics/astronomy	6,316	10	1,443	12	1,152	80	195	က	303	က	3,224	16
Environmental sciences	5,101	∞	1,449	12	1,737	13	554	10	142	-	1,218	9
Computer sciences	1,992	က	1,694	4	0	0	0	0	0	0	298	-
Academic departments	1,425	7	1,173	10	0	0	0	0	0	0	252	-
Computer facilities	292	-	521	4	0	0	0	0	0	0	46	*
Agricultural sciences	615	-	29	-	227	7	27	*	172	2	122	-
Biological sciences	20,955	34	2,122	18	3,778	28	3,611	65	9,217	06	2,227	Ξ
Other, multidisciplinary	1,603	ო	167	-	140	-	211	4	99	-	1,019	2
				Systems co	Systems costing \$1 million or more	on or more						
Total	337	100	131	100	69	100	19	100	0	0	128	100
Engineering	52	16	2	7	26	44	-	7	0	0	26	20
Chemistry	16	2	_	-	4	9	0	0	0	0	1	80
Physics/astronomy	66	29	0	0	7	11	17	93	0	0	75	29
Environmental sciences	25	7	2	4	က	9	0	0	0	0	16	13
Computer sciences	118	35	118	06	0	0	0	0	0	0	0	0
Academic departments	-	*	_	-	0	0	0	0	0	0	0	0
Computer facilities	117	35	117	88	0	0	0	0	0	0	0	0
Agricultural sciences	0	0	0	0	0	0	0	0	0	0	0	0
Biological sciences	23	7	က	က	19	33	0	0	0	0	0	0
Other, multidisciplinary	0	0	0	0	0	0	0	0	0	0	0	0
*												

* = less than 0.5 percent

NOTES: Table includes data for supersystems—large, integrated instrumentation systems/facilities generally costing \$1 million or more. Percentages may not total 100 because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Academic Research Instruments and Instrumentation Needs: 1993, available from << http://www.nsf.gov/sbe/srs/instrnnt/start.htm>>.

Appendix table 5-21. Aggregate purchase price and percentage distribution of academic research instruments, by field, price range, and type: 1993

	All instr	All instruments	Computers and data handling instruments	and data	Chromatographs and spectrometers	raphs and meters	Microscopy	copy	Bioanalytica instruments	lytical nents	Other instruments	ruments
Field	\$ million	Percent	\$ million	Percent	\$ million	Percent	\$ million	Percent	\$ million	Percent	\$ million	Percent
					All systems							
Total	6,255	100	1,851	30	1,286	21	547	6	468	7	2,103	34
Engineering	1,399	100	222	16	197	4	101	7	20	-	860	61
Chemistry	678	100	89	10	472	20	6	-	2	*	127	19
Physics/astronomy	1,062	100	136	13	175	16	38	4	20	7	694	65
Environmental sciences	969	100	180	26	171	25	115	17	2	-	224	32
Computer sciences	1,135	100	1,108	86	0	0	0	0	0	0	28	2
Academic departments	103	100	88	85	0	0	0	0	0	0	15	15
Computer facilities	1,032	100	1,020	66	0	0	0	0	0	0	12	-
Agricultural sciences	25	100	က	12	=======================================	42	2	7	2	20	2	18
Biological sciences	1,150	100	119	9;	250	25	259	23	414	36	109	တပု
Other, multidisciplinary	108	001	9L	14			23	LZ.	7	7	2/	25
			•	Systems co	costing \$20,000	666'666\$ - (
Total	4,366	100	784	18	1,124	56	527	12	468	11	1,463	34
Engineering	1,303	100	219	17	166	13	100	ω	20	2	799	61
Chemistry	651	100	22	6	467	72	6	-	2	*	116	18
Physics/astronomy	501	100	136	27	84	17	19	4	20	4	243	48
Environmental sciences	502	100	111	22	164	33	115	23	2	-	107	21
Computer sciences	157	100	129	82	0	0	0	0	0	0	28	18
Academic departments	100	100	85	85	0	0	0	0	0	0	15	15
Computer facilities	99	100	44	78	0	0	0	0	0	0	12	22
Agricultural sciences	25	100	က	12	=======================================	42	7	7	2	20	2	18
Biological sciences	1,118	100	113	10	223	20	259	23	414	37	109	10
Other, multidisciplinary	108	100	16	1	=	10	23	21	7	7	22	25
				Systems co	costing \$1 million	ion or more						
Total	1,889	100	1,067	22	162	6	20	-	0	0	640	34
Engineering	26	100	က	က	31	32	-	-	0	0	61	63
Chemistry	27	တ	=	တ	2	S	0	0	0	0	Ξ	တ
Physics/astronomy	561	100	0	0	91	16	19	ო	0	0	451	80
Environmental sciences	193	100	69	36	7	4	0	0	0	0	117	09
Computer sciences	978	100	978	100	0	0	0	0	0	0	0	0
Academic departments	2	တ	2	တ	0	0	0	0	0	0	0	0
Computer facilities	926	100	926	100	0	0	0	0	0	0	0	0
Agricultural sciences	0	0	0	0	0	0	0	0	0	0	0	0
Biological sciences	33	တ	9	တ	27	တ	0	0	0	0	0	0
Other, multidisciplinary	0	0	0	0	0	0	0	0	0	0	0	0
*)	0,0,40										

^{* =} less than 0.5 percent; S = fewer than 10 cases for analysis

NOTES: Table includes data for supersystems—large, integrated instrumentation systems/facilities generally costing \$1 million or more. Percentages may not total 100 because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Academic Research Instruments and instrumentation Needs: 1993, available from << http://www.nsf.gov/sbe/srs/instmnt/start.htm>>.

Appendix table 5-22. Current age of academic research instruments, by detailed type of instrument: 1993

			Current age	Current age (percent of total systems)	al systems)		
Time of instrument	- to	O-0	2-4 vears	A-6 years	λ-8-20 2769/	St. Vears	Mean age
Type of montainer.	200	U-z years	2-4 years	1-0 years	0-0 years	० - प्रत्या उ	(iii years)
Total, all instruments	100	17	23	21	16	23	5.8
Computers and data handling instruments	100	18	31	23	20	o	4.0
Computers/components costing \$1 million and over	100	17	7	20	7	0	3.5
Computers/components costing \$500,000 - \$999,999	100	10	44	36	9	4	3.7
Computers/components costing \$50,000 - \$499,999	100	12	26	23	27	12	4.6
Computers/components costing \$20,000 - \$49,999	100	21	34	22	16	7	3.7
Chromatographs and spectrometers	100	1	21	19	15	32	0.9
Chromatographs and elemental analyzers	100	16	27	20	14	22	4.8
Electron/auger/ion scattering	100	21	10	18	17	34	6.1
UV/visible/infrared spectrophotometer	100	12	18	23	13	34	5.8
NMR/EPR spectrometer	100	6	10	21	15	45	8.4
X-ray diffraction systems	100	23	10	16	21	29	5.9
Other spectroscopy instruments	100	12	23	15	14	36	6.9
Microscopy instruments	100	18	23	18	15	27	8.9
Electron microscopes	100	9	21	21	12	41	9.4
Other microscopy instruments	100	24	23	16	16	21	5.5
Bioanalytical instruments	100	12	16	25	16	31	8.2
Cell sorters/counters, cytometers	100	23	22	18	21	16	4.6
Centrifuges and accessories	100	Ξ	16	27	16	29	7.5
DNA/protein synthesizers/sequencers/analyzers	100	26	15	22	18	19	6.5
Growth/environmental chambers	100	Ξ	22	59	41	24	5.9
Scintillation/gamma radiation/counters/detectors	100	7	15	22	13	43	10.9
Other instruments	100	20	23	19	16	21	5.3
Electronics instruments (cameras, etc.)	100	7	17	27	31	18	5.5
Temperature/pressure control/measurement instruments	100	22	19	21	18	20	5.0
Lasers and optical instruments	100	30	21	23	80	19	4.2
Robots, manufacturing machines	100	47	22	6	10	12	3.4
Telescopes/astronomical	100	*	58	4	-	36	6.9
Nuclear reactors/nuclear science instrument systems	100	0	7	25	36	32	10.7
Research vessels/planes/helicopters	100	0	38	24	13	25	5.8
Wind/wave/water/shock tunnels	တ	0	0	S	0	တ	S
Molecular/electron/ion beam systems	100	43	80	Ξ	4	34	5.5
Major prototype systems	100	7	45	6	19	21	7.1
Other, not elsewhere classified	100	18	24	18	17	23	2.7

^{* =} less than 0.5 percent; S = fewer than 10 cases for analysis

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Academic Research Instruments and Instrumentation Needs: 1993, available from << http://www.nsf.gov/sbe/srs/instrnnt/start.htm>>.

Science & Engineering Indicators – 1998

NOTE: Table does not include data for supersystems—large, integrated instrumentation systems/facilities generally costing \$1 million or more.

Appendix table 5-23. Academic employment of doctoral scientists and engineers, by type of position and field: 1973-95 (Thousands)

Field	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
					Total							
Total science & engineering	118.0	134.1	145.5	155.4	167.1	176.2	190.3	196.0	206.7	210.6	213.8	217.5
Total sciences	105.6	120.7	130.7	139.5	151.0	158.1	170.4	174.8	183.9	187.8	190.6	193.7
Physical sciences	22.1	23.6	25.0	24.6	25.4	25.1	27.0	27.2	27.7	27.7	28.6	29.3
Mathematics	9.7	11.0	11.7	12.2	12.4	12.9	13.6	13.8	14.5	15.2	15.5	14.6
Computer sciences	Ϋ́	ΑΝ	Ϋ́	0.1	0.3	0.5	0.8	- -	1.5	2.0	2.5	3.1
Environmental sciences	3.4	3.9	4.2	4.2	4.6	4.8	5.2	5.6	5.9	0.9	6.4	6.4
Life sciences	34.9	39.4	42.6	47.0	51.3	54.9	58.7	61.3	64.8	6.99	68.2	71.6
Psychology	12.2	14.8	16.2	17.7	20.1	21.0	23.1	23.7	25.0	25.2	25.0	26.1
Social sciences	23.4	28.0	31.1	33.6	36.9	38.9	42.0	42.2	44.5	44.8	44.4	42.5
Engineering	12.4	13.4	14.8	15.8	16.1	18.1	19.9	21.2	22.9	22.8	23.1	23.8
				Total	full-time fac	faculty						
Total science & engineering	103.3	116.4	125.6	131.2	142.0	148.4	156.9	164.5	169.8	173.1	172.4	171.4
Total sciences	92.0	104.2	112.2	116.9	127.3	132.0	139.0	145.2	149.6	153.1	152.3	151.3
Physical sciences	17.8	18.9	20.0	20.0	20.5	20.2	21.2	22.0	21.5	21.7	21.3	20.9
Mathematics	9.3	10.4	10.9	11.4	11.7	12.3	12.7	12.9	13.5	14.2	14.7	13.0
Computer sciences	Ϋ́	ΑΝ	Ϋ́	0.1	0.3	0.4	0.7	6.0	1.3	1.8	2.3	2.8
Environmental sciences	3.0	3.4	3.6	3.5	3.8	4.0	4.2	4.4	4.7	4.5	4.5	4.7
Life sciences	29.5	33.1	34.9	37.3	40.9	43.5	45.6	48.1	49.3	51.1	50.8	52.8
Psychology	10.8	12.8	13.9	14.3	16.4	17.3	18.5	19.2	20.2	20.7	19.5	20.1
Social sciences	21.6	25.5	28.8	30.4	33.7	34.4	36.1	37.7	39.0	39.0	39.2	37.1
Engineering	11.3	12.2	13.5	14.3	14.7	16.4	17.9	19.3	20.2	20.1	20.1	20.0
				Full-tin	ne senior fa	faculty						
Total science & engineering	74.0	84.3	200.	97.2	107.4	115.6	119.8	127.3	131.1	133.0	128.6	127.3
Total sciences	65.3	74.5	80.0	85.6	95.0	101.9	105.9	112.0	115.2	117.2	113.0	112.1
Physical sciences	13.0	14.6	15.3	16.0	16.9	17.1	17.7	18.3	17.8	17.6	16.9	16.4
Mathematics	5.9	6.9	9.7	8.3	9.1	9.7	10.0	10.5	10.9	11.8	11.5	10.6
Computer sciences	Α	Ϋ́	Ϋ́	0.0	0.0	0.1	0.1	0.3	9.4	6.0	6.0	1.7
Environmental sciences	2.2	2.5	2.7	2.8	2.9	3.1	3.1	3.2	3.6	3.6	3.7	3.6
Life sciences	21.0	23.4	24.6	27.0	29.6	32.6	33.7	35.8	36.4	37.4	35.8	37.2
Psychology	7.3	8.7	9.1	6.6	11.7	12.8	13.5	14.3	15.0	15.3	14.3	14.5
Social sciences	15.9	18.5	20.7	21.7	24.9	26.4	27.7	29.5	31.1	30.6	29.9	28.1
Engineering	8.7	9.7	10.7	11.6	12.4	13.7	13.9	15.3	15.9	15.8	15.7	15.3

Science & Engineering Indicators – 1998

Academic employment of doctoral scientists and engineers, by type of position and field: 1973-95 (Thousands) Appendix table 5-23.

7 7 7 1	1020	1004	7021	4070	000	000	1000	1001	000	700	000	1000
ספו	0.761	0.00	1.161	6/61	1001	2002	000	1961	6061	1 661	000	000
				Full-ti	Full-time junior faculty	culty						
Total science & engineering	29.3	32.1	34.9	34.0	34.6	32.8	37.2	37.2	38.7	40.1	43.8	44.0
Total sciences	26.7	29.6	32.2	31.3	32.3	30.2	33.1	33.2	34.4	35.8	39.3	39.3
Physical sciences	4.8	4.3	4.8	4.0	3.7	3.1	3.5	3.6	3.7	4.1	4.3	4.5
Mathematics	3.3	3.5	3.3	3.1	2.6	2.5	2.7	2.4	2.6	2.4	3.2	2.4
Computer sciences	Ν	Ϋ́	Ϋ́	0.1	0.2	0.3	9.0	9.0	6.0	1.0	1.4	1.2
Environmental sciences	9.0	6.0	6.0	0.7	6.0	6.0	1.1	- -	1.1	6.0	6.0	1.1
Life sciences	8.5	9.7	10.3	10.3	11.3	10.8	11.9	12.3	12.8	13.7	15.0	15.6
Psychology	3.6	4.2	4.8	4.4	4.8	4.5	5.0	4.9	5.2	5.4	5.2	5.5
Social sciences	2.7	7.1	8.2	9.8	8.8	8.1	8.4	8.2	7.9	8.4	9.3	0.6
Engineering	5.6	2.5	2.7	2.8	2.3	2.7	4.0	4.0	4.3	4.3	4.5	4.8
				All other	All other full-time positions	sitions						
Total science & engineering	7.6	8.3	8.8	11.4	12.6	13.4	18.1	16.4	19.2	20.2	22.2	23.9
Total sciences	8.9	7.4	8.0	10.5	11.5	12.3	16.6	15.3	17.7	18.4	20.7	21.7
Physical sciences	1.9	1.9	2.1	2.0	2.4	2.5	3.0	2.6	3.3	3.2	3.7	3.8
Mathematics	0.2	0.3	0.4	9.0	0.4	0.3	0.5	0.4	0.5	9.0	0.5	9.0
Computer sciences	Ν	Ϋ́	A A	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Environmental sciences	0.3	0.3	0.3	0.5	0.5	0.5	0.7	8.0	0.7	6.0	1.1	-:
Life sciences	2.5	2.4	2.8	3.9	4.0	4.6	6.2	0.9	6.7	7.2	7.7	8.4
Psychology	0.8	1.0	1.2	1.8	2.2	2.2	2.9	2.8	2.9	2.8	3.9	3.9
Social sciences	1.0	1.5	1.2	1.9	2.0	2.2	3.2	2.6	3.5	3.5	3.7	3.6
Engineering	0.8	0.0	0.8	6.0	1.1	1.1	1.5	1.1	1.5	1.8	1.5	2.1
			Ь	Postdoctoral	and part-tir	and part-time positions	•					
Total science & engineering	7.1	9.5	11.0	12.7	12.6	14.4	15.3	15.1	17.8	17.2	19.2	22.3
Total sciences	8.9	9.1	10.5	12.1	12.2	13.7	14.8	14.3	16.6	16.3	17.7	20.7
Physical sciences	2.3	2.7	2.8	2.7	2.5	2.4	2.8	2.6	2.9	2.8	3.7	4.7
Mathematics	0.2	0.3	0.3	4.0	0.3	4.0	0.3	4.0	0.5	0.4	0.3	1.0
Computer sciences	Ν	Ϋ́	A A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Environmental sciences	0.1	0.2	0.2	0.2	0.3	0.3	0.3	4.0	0.5	9.0	0.8	0.7
Life sciences	2.8	4.0	2.0	5.8	6.4	8.9	6.9	7.2	8.8	9.8	9.7	10.4
Psychology	9.0	6.0	7.	1.6	4.1	1.6	1.8	1.7	1.9	1.6	1.6	2.2
Social sciences	0.8	1.0	1.	1.3	1.3	2.2	2.6	1.9	2.1	2.3	1.5	1.8
Engineering	0.3	0.4	0.5	9.0	0.3	0.7	0.5	0.8	Ξ	6.0	1.5	1.6

NA = not available

NOTES: Details may not add to totals because of rounding. Data exclude university-managed federally funded research and development centers. Due to survey coverage, the data also exclude scientists and engineers with doctorates from foreign institutions. Field of employment data were discontinued after the 1991 survey and are not shown. Faculty is defined by position. Senior faculty includes full and associate professors; junior faculty members are either assistant professors or instructors.

SOURCE: National Science Foundation, Science Resources Studies Division, Characteristics of Doctoral Scientists and Engineers in the United States: 1995, Detailed Statistical Tables, NSF 97-333 (Arlington, VA: 1997).

See figure 5-10.

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Appendix table 5-24. Academic employment of doctoral scientists and engineers, by degree field, sex, and type of position: 1973-95 (Thousands)

Field and sex	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				Total aca	Fotal academic employmen	oyment						
All, total S&E	118.0	134.1	145.5	155.4	167.1	176.2	190.3	196.0	206.7	210.6	213.8	217.5
Total sciences	105.6	120.7	130.7	139.5	151.0	158.1	170.4	174.8	183.9	187.8	190.6	193.7
Physical sciences	22.1	23.6	25.0	24.6	25.4	25.1	27.0	27.2	27.7	27.7	28.6	29.3
Mathematics	9.7	11.0	11.7	12.2	12.4	12.9	13.6	13.8	14.5	15.2	15.5	14.6
Computer sciences	Ϋ́	Ϋ́Z	Ϋ́	0.1	0.3	0.5	0.8	1.1	1.5	2.0	2.5	3.1
Environmental sciences	3.4	3.9	4.2	4.2	4.6	4.8	5.2	5.6	5.9	0.9	6.4	6.4
Life sciences	34.9	39.4	42.6	47.0	51.3	54.9	58.7	61.3	64.8	6.99	68.2	71.6
Psychology	12.2	14.8	16.2	17.7	20.1	21.0	23.1	23.7	25.0	25.2	25.0	26.1
Social sciences	23.4	28.0	31.1	33.6	36.9	38.9	42.0	42.2	44.5	44.8	44.4	42.5
Engineering	12.4	13.4	14.8	15.8	16.1	18.1	19.9	21.2	22.9	22.8	23.1	23.8
Male, total S&E	107.3	120.3	129.0	136.0	144.0	149.8	159.2	162.0	168.0	168.7	166.9	165.1
Total sciences	94.9	106.9	114.3	120.3	128.1	132.0	139.7	141.4	145.8	146.9	144.8	142.9
Physical sciences	20.7	22.1	23.3	22.9	23.5	23.2	24.9	24.9	25.2	25.4	25.7	25.9
Mathematics	9.0	10.3	10.8	11.3	11.3	11.8	12.3	12.5	13.0	13.9	13.7	12.8
Computer sciences	0.0	0.0	0.0	0.1	0.3	0.4	0.7	6.0	1.3	1.6	2.1	2.5
Environmental sciences	3.3	3.8	4.1	4.0	4.3	4.5	4.9	5.1	5.3	5.4	2.7	5.5
Life sciences	30.8	34.3	36.6	40.1	42.9	44.5	46.7	47.9	49.5	50.1	49.4	50.1
Psychology	10.0	11.8	12.6	13.5	14.9	15.1	16.0	16.2	16.5	16.0	14.7	14.7
Social sciences	21.0	24.7	26.9	28.5	30.9	32.3	34.3	33.9	35.1	34.6	33.4	31.3
Engineering	12.3	13.3	14.7	15.7	15.9	17.8	19.5	20.6	22.2	21.8	22.1	22.3
Female, total S&E	10.7	13.8	16.5	19.4	23.1	26.5	31.1	34.0	38.7	41.9	46.9	52.4
Total sciences	10.7	13.8	16.4	19.2	22.9	26.1	30.7	33.5	38.0	40.9	45.8	50.9
Physical sciences	1 .	1.5	1.6	1.7	1.9	1.9	2.1	2.3	2.5	2.3	2.9	3.5
Mathematics	9.0	0.8	6.0	6.0	1.1	1.1	1.3	1.4	1.5	4.1	1.7	1.8
Computer sciences	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.4	0.5	9.0
Environmental sciences	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	9.0	0.7	0.7	6.0
Life sciences	4.0	5.1	0.9	6.9	8.4	10.3	12.1	13.3	15.3	16.8	18.8	21.5
Psychology	2.2	3.0	3.6	4.3	5.2	5.9	7.1	9.7	8.5	9.2	10.3	11.5
Social sciences	2.4	3.3	4.2	5.2	0.9	6.5	7.7	8.3	9.4	10.2	10.9	11.2
Engineering	0.1	0.1	0.1	0.2	0.2	0.3	0.4	9.0	0.7	1.0	1.1	1.5

Appendix table 5-24. Academic employment of doctoral scientists and engineers, by degree field, sex, and type of position: 1973-95 (Thousands)

Field and sex	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				Full-tim	ne senior faculty	culty						
All, total S&E	74.0	84.3	90.7	97.2	107.4	115.6	119.8	127.3	131.1	133.0	128.6	127.3
Total sciences	65.3	74.5	80.0	85.6	95.0	101.9	105.9	112.0	115.2	117.2	113.0	112.1
Physical sciences	13.0	14.6	15.3	16.0	16.9	17.1	17.7	18.3	17.8	17.6	16.9	16.4
Mathematics	5.9	6.9	7.6	8.3	9.1	9.7	10.0	10.5	10.9	11.8	11.5	10.6
Computer sciences	ΑN	Ϋ́	Ϋ́	0.0	0.0	0.1	0.1	0.3	0.4	6.0	6.0	1.7
Environmental sciences	2.2	2.5	2.7	2.8	2.9	3.1	3.1	3.2	3.6	3.6	3.7	3.6
Life sciences	21.0	23.4	24.6	27.0	29.6	32.6	33.7	35.8	36.4	37.4	35.8	37.2
Psychology	7.3	8.7	9.1	6.6	11.7	12.8	13.5	14.3	15.0	15.3	14.3	14.5
Social sciences	15.9	18.5	20.7	21.7	24.9	26.4	27.7	29.5	31.1	30.6	29.9	28.1
Engineering	8.7	6.7	10.7	11.6	12.4	13.7	13.9	15.3	15.9	15.8	15.7	15.3
Male, total S&E	69.7	78.9	84.7	90.3	98.7	104.9	107.4	113.3	115.3	115.5	110.3	107.0
Total sciences	61.0	69.2	74.0	78.7	86.5	91.4	93.7	98.2	9.66	100.1	95.0	92.2
Physical sciences	12.5	14.1	14.7	15.4	16.2	16.4	17.0	17.5	16.9	16.9	16.0	15.4
Mathematics	9.9	6.5	7.2	7.9	8.6	9.1	9.3	8.6	10.0	10.8	10.5	8.6
Computer sciences	ΑN	Ϋ́	ΑN	0.0	0.0	0.1	0.1	0.3	0.4	0.8	0.8	1.4
Environmental sciences	2.2	2.5	2.7	2.7	2.8	3.0	3.0	3.1	3.4	3.4	3.5	3.4
Life sciences	19.5	21.6	22.7	24.9	26.9	29.1	29.4	31.0	31.1	31.4	29.3	29.3
Psychology	6.4	9.7	7.8	8.4	9.7	10.5	10.8	11.2	11.5	11.3	10.2	10.1
Social sciences	14.7	16.9	18.8	19.5	22.3	23.2	24.2	25.4	26.4	25.5	24.7	22.8
Engineering	8.7	9.7	10.7	11.5	12.2	13.6	13.7	15.1	15.7	15.4	15.3	14.8
Female, total S&E	4.3	5.4	0.9	7.0	9.8	10.7	12.4	14.0	15.8	17.6	18.3	20.3
Total sciences	4.3	5.4	0.9	6.9	8.5	10.5	12.2	13.8	15.6	17.1	18.0	19.8
Physical sciences	0.5	0.5	9.0	9.0	9.0	0.7	0.8	6.0	6.0	0.7	6.0	1.0
Mathematics	0.3	0.4	0.4	4.0	0.5	9.0	0.7	0.8	6.0	1.0	1.0	0.8
Computer sciences	A A	Ϋ́	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.3
Environmental sciences	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Life sciences	1.5	1.8	1.9	2.2	2.7	3.5	4.3	4.8	5.4	6.1	6.5	7.8
Psychology	8.0	1.	1.2	4.1	2.0	2.4	2.7	3.1	3.5	4.0	4.1	4.4
Social sciences	1.	1.5	1.8	2.2	2.6	3.1	3.6	4.1	4.7	5.1	5.2	5.3
Engineering	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.4	0.3	0.5

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Appendix table 5-24.

Academic employment of doctoral scientists and engineers, by degree field, sex, and type of position: 1973-95 (Thousands)

Field and sex	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				Full-ti	Full-time junior faculty	culty						
All, total S&E	29.3	32.1	34.9	34.0	34.6	32.8	37.2	37.2	38.7	40.1	43.8	44.0
Total sciences	26.7	29.6	32.2	31.3	32.3	30.2	33.1	33.2	34.4	35.8	39.3	39.3
Physical sciences	4.8	4.3	4.8	4.0	3.7	3.1	3.5	3.6	3.7	4.1	4.3	4.5
Mathematics	3.3	3.5	3.3	3.1	2.6	2.5	2.7	2.4	2.6	2.4	3.2	2.4
Computer sciences	Ϋ́	Ϋ́	Ϋ́	0.1	0.2	0.3	9.0	9.0	6.0	1.0	1.4	1.2
Environmental sciences	0.8	6.0	6.0	0.7	6.0	6.0	1.1	1.1	1.1	6.0	6.0	1.1
Life sciences	8.5	9.7	10.3	10.3	11.3	10.8	11.9	12.3	12.8	13.7	15.0	15.6
Psychology	3.6	4.2	4.8	4.4	4.8	4.5	5.0	4.9	5.2	5.4	5.2	5.5
Social sciences	2.5	7.1	8.2	8.6	8.8	8.1	8.4	8.2	7.9	8.4	6.9	0.6
Engineering	5.6	2.5	2.7	2.8	2.3	2.7	4.0	4.0	4.3	4.3	4.5	8.4
Male, total S&E	26.0	27.5	28.9	27.3	27.1	25.2	27.8	27.2	27.6	28.1	29.7	28.5
Total sciences	23.5	25.1	26.3	24.6	24.9	22.6	23.9	23.4	23.5	24.2	25.7	24.4
Physical sciences	4.5	4.0	4.4	3.6	3.2	2.7	3.0	3.2	3.2	3.4	3.5	3.4
Mathematics	3.1	3.2	2.9	2.7	2.2	2.2	2.3	2.0	2.2	2.2	2.7	2.0
Computer sciences	Ϋ́	Ϋ́	Ϋ́	0.1	0.2	0.3	0.5	0.5	0.8	0.8	1.	1.0
Environmental sciences	0.7	6.0	9.0	2.0	6.0	8.0	6.0	6.0	6.0	0.7	0.7	0.7
Life sciences	7.5	8.1	8.4	8.1	8.9	8.1	8.5	8.5	8.4	8.8	9.5	9.5
Psychology	2.7	3.0	3.3	2.8	3.0	2.6	2.7	2.7	2.9	3.0	2.3	2.4
Social sciences	5.0	5.9	6.5	9.9	6.5	5.9	0.9	5.6	5.2	5.3	5.9	5.5
Engineering	5.6	2.4	2.7	2.7	2.2	2.6	3.8	3.8	4.0	3.9	4.0	4.1
Female, total S&E	3.3	4.6	0.9	8.9	7.5	7.7	9.4	10.0	11.2	12.0	14.1	15.6
Total sciences	3.3	4.6	5.9	6.7	7.4	7.6	9.2	9.7	10.8	11.6	13.6	14.9
Physical sciences	0.3	0.3	0.4	4.0	4.0	4.0	0.5	0.5	0.5	0.7	6.0	1.1
Mathematics	0.2	0.3	0.4	9.0	0.4	0.3	0.4	0.4	0.4	0.3	0.5	0.5
Computer sciences	Ϋ́	N A	Ą	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.2
Environmental sciences	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.4
Life sciences	. .	1.6	1.9	2.2	2.4	2.7	3.4	3.8	4.5	4.9	5.5	6.1
Psychology	6.0	1.2	1.5	1.6	1.8	1.9	2.3	2.2	2.3	2.4	2.9	3.1
Social sciences	8.0	1.2	1.7	2.1	2.3	2.1	2.4	2.6	2.7	3.0	3.4	3.5
Engineering	0.0	0:0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.7

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Appendix table 5-24. Academic employment of doctoral scientists and engineers, by degree field, sex, and type of position: 1973-95 (Thousands)

Field and sex	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				All other	other full-time po	positions						
All, total S&E	9.7	8.3	8.8	11.4	12.6	13.4	18.1	16.4	19.2	20.2	22.2	23.9
Total sciences	8.9	7.4	8.0	10.5	11.5	12.3	16.6	15.3	17.7	18.4	20.7	21.7
Physical sciences	6:1	1.9	2.1	2.0	2.4	2.5	3.0	2.6	3.3	3.2	3.7	3.8
Mathematics	0.2	0.3	0.4	0.4	0.4	0.3	0.5	0.4	0.5	9.0	0.5	9.0
Computer sciences	Ϋ́	Υ V	Ϋ́	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Environmental sciences	0.3	0.3	0.3	0.5	0.5	0.5	0.7	0.8	0.7	6.0	- -	
Life sciences	2.5	2.4	2.8	3.9	4.0	4.6	6.2	0.9	6.7	7.2	7.7	8.4
Psychology	8.0	1.0	1.2	1.8	2.2	2.2	2.9	2.8	2.9	2.8	3.9	3.9
Social sciences	1.0	1.5	1.2	1.9	2.0	2.2	3.2	2.6	3.5	3.5	3.7	3.6
Engineering	9.0	6.0	0.8	6.0	- -	1.	1.5	1.	1.5	1.8	1.5	2.1
Male, total S&E	6.5	7.2	7.4	9.5	10.0	10.3	14.3	12.0	13.9	14.4	15.4	16.1
Total sciences	2.7	6.4	6.7	8.6	8.9	9.3	12.8	10.9	12.5	12.8	14.0	14.1
Physical sciences	1 .8	1.8	1.9	1.8	2.1	2.2	2.7	2.2	2.9	2.9	3.3	3.2
Mathematics	0.2	0.3	0.4	0.3	0.3	0.2	0.4	0.4	0.4	9.0	0.4	0.5
Computer sciences	ΑN	Ν Α	Ϋ́	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Environmental sciences	0.3	0.3	0.3	0.5	0.5	0.5	0.7	0.7	9.0	0.7	6.0	6.0
Life sciences	2.0	1.9	2.2	3.0	3.0	3.2	4.6	4.1	4.6	4.9	5.1	5.6
Psychology	0.7	0.8	6.0	1 .	4.1	4.	1.8	1.6	1.5	1.2	1.9	1.7
Social sciences	9.0	1.3	6:0	1.6	1.6	1.7	2.5	1.8	2.4	2.4	2.2	2.1
Engineering	0.8	6:0	0.8	6.0	- :	1.0	1.5	1.0	1.4	1.7	1.5	2.0
Female, total S&E	[:	[:	4.	2.0	5.6	3.1	3.8	4.5	5.3	5.8	6.7	7.7
Total sciences		1.	4.1	2.0	2.6	3.1	3.8	4.4	5.2	2.7	6.7	9.7
Physical sciences	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.3	0.4	9.0
Mathematics	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
Computer sciences	ΑN	ΑΝ	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2
Life sciences	9.0	0.5	9.0	6.0	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.8
Psychology	0.2	0.2	0.3	0.5	8.0	8.0	. .	1.3	4.1	1.6	2.0	2.2
Social sciences	0.2	0.2	0.2	0.3	4.0	0.5	0.7	8.0	1.1	[:	1.5	1.5
Engineering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1

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Academic employment of doctoral scientists and engineers, by degree field, sex, and type of position: 1973-95 Appendix table 5-24. (Thousands)

Field and sex	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				2 2	and nart-time nositions	e nositions						
			-	_		S positions						
All, total S&E	7.1	9.5	11.0	12.7	12.6	14.4	15.3	15.1	17.8	17.2	19.2	22.3
Total sciences	8.9	9.1	10.5	12.1	12.2	13.7	14.8	14.3	16.6	16.3	17.7	20.7
Physical sciences	2.3	2.7	2.8	2.7	2.5	2.4	2.8	2.6	2.9	2.8	3.7	4.7
Mathematics	0.2	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.5	0.4	0.3	1.0
Computer sciences	Ϋ́	ΑN	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Environmental sciences	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.5	9.0	0.8	0.7
Life sciences	2.8	4.0	5.0	5.8	6.4	8.9	6.9	7.2	8.8	8.6	2.6	10.4
Psychology	9.0	6.0	1.	1.6	1.4	1.6	1.8	1.7	1.9	1.6	1.6	2.2
Social sciences	0.8	1.0	1.1	1.3	1.3	2.2	2.6	1.9	2.1	2.3	1.5	1.8
Engineering	0.3	9.4	0.5	9.0	0.3	0.7	0.5	8.0	[:	6.0	1.5	1.6
Male, total S&E	2.0	6.7	7.8	9.0	8.2	9.4	8.6	9.5	11.3	10.7	11.5	13.5
Total sciences	4.7	6.3	7.3	8.4	7.8	8.7	9.3	8.8	10.2	9.8	10.1	12.1
Physical sciences	1.9	2.2	2.3	2.2	1.9	1.9	2.2	2.0	2.3	2.2	3.0	3.8
Mathematics	0.1	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.4	0.3	0.1	9.0
Computer sciences	Ϋ́	ΑN	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Environmental sciences	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5	9.0	0.5
Life sciences	2.0	2.7	3.3	4.1	4.1	4.1	4.2	4.3	5.5	5.1	5.6	2.5
Psychology	0.2	4.0	9.0	6.0	8.0	0.7	8.0	0.7	9.0	0.4	0.2	0.5
Social sciences	0.5	9.0	0.7	0.8	9.0	1.5	1.6	- -	1.	4.1	9.0	6.0
Engineering	0.3	0.3	0.5	9.0	0.3	9.0	0.5	0.7	Ξ:	6.0	1.3	1.4
Female, total S&E	2.1	2.8	3.2	3.7	4.4	2.0	5.6	5.6	6.4	9.9	7.7	8.8
Total sciences	2.1	2.8	3.2	3.7	4.4	5.0	5.5	5.5	6.4	6.5	7.6	8.5
Physical sciences	4.0	0.5	0.5	0.5	0.5	0.5	0.5	9.0	9.0	9.0	8.0	8.0
Mathematics	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4
Computer sciences	Ϋ́	ΑN	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1
Life sciences	6.0	1.3	1.6	1.8 8.	2.3	2.7	2.8	2.9	3.3	3.5	4.1	4.7
Psychology	4.0	0.5	0.5	0.7	0.7	8.0	1.0	1.0	1.3	1.2	4.	1.7
Social sciences	0.3	4.0	4.0	0.5	0.7	0.7	1.0	8.0	1.0	6.0	6.0	6.0
Engineering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.3

NA = not available

NOTES: Data exclude university-managed federally funded research and development centers. Due to survey coverage, the data also exclude scientists and engineers with doctorates from foreign institutions. Field of employment data were discontinued after the 1991 survey and are not shown. Faculty is defined by position. Senior faculty includes full and associate professors; junior faculty members are either assistant professors or instructors.

SOURCE: National Science Foundation, Science Resources Studies Division, Characteristics of Doctoral Scientists and Engineers in the United States: 1995, Detailed Statistical Tables, NSF 97-333 (Arlington, VA: 1997).

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Appendix table 5-25.
Academic employment of doctoral scientists and engineers, by degree field, race/ethnicity, and type of position: 1973-95 (Thousands)

Field and race/ethnicity	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				Total aca	cademic employment	oyment						
All, total S&E	118.0	134.1	145.5	155.4	167.1	176.2	190.3	196.0	206.7	210.6	213.8	217.5
Total sciences	105.6	120.7	130.7	139.5	151.0	158.1	170.4	174.8	183.9	187.8	190.6	193.7
Physical sciences	22.1	23.6	25.0	24.6	25.4	25.1	27.0	27.2	27.7	27.7	28.6	29.3
Mathematics	6.7	11.0	11.7	12.2	12.4	12.9	13.6	13.8	14.5	15.2	15.5	14.6
Computer sciences	¥	Ϋ́	Ϋ́	0.1	0.3	0.5	0.8	1.1	1.5	2.0	2.5	3.1
Environmental sciences	3.4	3.9	4.2	4.2	4.6	4.8	5.2	5.6	5.9	0.9	6.4	6.4
Life sciences	34.9	39.4	42.6	47.0	51.3	54.9	58.7	61.3	64.8	6.99	68.2	71.6
Psychology	12.2	14.8	16.2	17.7	20.1	21.0	23.1	23.7	25.0	25.2	25.0	26.1
Social sciences	23.4	28.0	31.1	33.6	36.9	38.9	42.0	42.2	44.5	44.8	44.4	42.5
Engineering	12.4	13.4	14.8	15.8	16.1	18.1	19.9	21.2	22.9	22.8	23.1	23.8
White non-Hispanic, total S&E	107.8	121.6	131.5	140.0	150.0	157.3	168.5	172.9	181.1	183.5	181.8	182.6
Total sciences	97.0	110.0	118.8	126.5	135.9	142.1	152.1	155.8	163.0	165.3	164.3	165.0
Physical sciences	19.7	21.1	22.1	21.9	22.3	21.9	23.4	23.3	23.7	23.8	23.4	23.8
Mathematics	8.8	10.0	10.6	10.8	11.0	11.5	11.9	12.2	12.6	13.0	12.9	12.0
Computer sciences	Ą	₹ Z	Ą	0.1	0.2	4.0	9.0	6.0	1.	4.1	1.6	2.1
Environmental sciences	3.3	3.7	4.0	4.0	4.3	4.5	4.9	5.2	5.5	5.7	5.9	5.7
Life sciences	32.2	35.8	38.8	42.4	46.1	49.4	52.7	54.7	57.6	59.2	59.1	61.3
Psychology	11.6	13.9	15.2	16.8	18.8	19.6	21.3	22.0	23.2	23.2	22.9	23.6
Social sciences	21.4	25.3	28.2	30.5	33.1	34.7	37.3	37.6	39.4	39.1	38.6	36.5
Engineering	10.8	11.6	12.6	13.5	14.0	15.2	16.4	17.2	18.1	18.2	17.5	17.6
Asian, total S&E	5.1	6.1	6.8	9.8	10.9	11.8	14.1	15.1	16.4	16.9	21.0	22.5
Total sciences	4.0	5.0	5.4	7.9	9.2	9.5	11.1	11.6	12.3	13.2	16.3	17.6
Physical sciences		1.3	4.1	1.9	2.0	2.2	2.6	2.9	2.8	2.6	3.8	4.1
Mathematics	9.4	0.5	0.5	6.0	6.0	1.0	1.1	1.1	1.3	1.6	1.9	1.8
Computer sciences	Ϋ́	Ą V	Ϋ́	0.0	0.1	0.1	0.1	0.1	0.3	0.5	8.0	6.0
Environmental sciences	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	4.0	0.5
Life sciences	1.3	1.8	2.0	3.1	3.6	3.6	4.0	4.5	4.8	5.1	6.4	8.9
Psychology	0.1	0.2	0.2	0.3	9.4	0.4	9.4	0.5	9.0	0.5	0.5	9.0
Social sciences	1.0	- -	1.2	1.6	2.0	2.0	2.5	2.2	2.4	5.6	2.7	2.8
Engineering		- .	.3 5	1.9	. 8.	2.4	3.0	3.5	4.1	3.7	4.7	4.9
Underrep. minorities, total S&E ^a	2.4	3.2	3.8	5.0	0.9	8.9	7.3	8.0	9.5	10.2	11.5	12.8
Total sciences	2.3	3.0	3.5	4.6	2.5	6.2	8.9	7.4	8.5	9.3	10.5	11.5
Physical sciences	0.5	0.5	0.5	0.7	6.0	1.0	6.0	1.0	[.	1.3	1.6	1.5
Mathematics	0.2	0.2	0.3	4.0	4.0	0.4	0.5	0.5	9.0	9.0	9.0	6.0
Computer sciences	¥	Υ	ΥN	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2
Environmental sciences	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Life sciences	6:0	. .	1.2	4.1	1.6	1.8	1.9	2.1	2.5	2.6	2.9	3.6
Psychology	0.3	0.4	9.0	9.0	6.0	1.0	1.3	1.2	د .	1.5	1.7	2.0
Social sciences	0.5	0.8	0.8	1.5	8. 9	2.0	2.2	2.4	2.8		3.2	3.2
Engineering	0.2	0.2	0.3	0.4	0.3	0.5	0.5	0.5	0.7	6:0	1.0	1.3
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Appendix table 5-25. Academic employment of doctoral scientists and engineers, by degree field, race/ethnicity, and type of position: 1973-95 (Thousands)

Field and race/ethnicity	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
Black, total S&E	1.3	1.7	1.8	2.0	2.6	3.3	3.4	3.6	3.8		4.9	6.1
Total sciences	1 .3	1.6	1.7	1.9	2.5	3.0	3.2	3.3	3.6	4.3	4.6	5.6
Physical sciences	0.3	0.2	0.2	0.2	0.3	0.4	0.3	0.3	0.3	0.4	0.5	9.0
Mathematics	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Computer sciences	ΑĀ	Ϋ́Z	Ϋ́Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Life sciences	9.4	9.0	9.0	9.0	9.0	0.8	6.0	6.0	1.0	1.2	1.3	1.8
Psychology	0.2	0.3	0.3	0.3	0.4	9.0	9.0	0.7	0.7	6.0	6.0	
Social sciences	0.3	0.5	0.5	0.7	1.0	1.1	1.3	1.2	1.3	1.6	1.6	1.8
Engineering	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.3	4.0	0.3	0.5
Hispanic, total S&E	6.0	1.2	1.6	2.4	2.5	5.6	3.1	3.4	4.3	4.5	2.0	2.7
Total sciences	9.0	1.	4.1	2.1	2.4	2.4	2.8	3.1	3.9	4.1	4.4	5.0
Physical sciences	0.2	0.2	0.3	0.4	0.4	0.5	0.5	0.5	9.0	0.8	0.8	0.8
Mathematics	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	9.4	0.4	4.0	0.5
Computer sciences	A A	Ϋ́	Ϋ́Z	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1
Environmental sciences	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Life sciences	9.4	0.4	0.5	0.7	8.0	8.0	8.0	1.0	1.2	1.2	1.3	1.6
Psychology	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	9.0	9.0
Social sciences	0.1	0.2	0.2	9.0	0.5	9.0	0.7	8.0	. .		1.2	1.1
Engineering	0.1	0.1	0.2	0.3	0.1	0.2	0.3	0.3	9.4	9.4	0.5	0.7
Native American, total S&E	0.2	0.3	0.4	9.0	8.0	8.0		6.0	[:	6.0	1.0	1.0
Total sciences	0.2	0.3	0.4	9.0	0.7	0.7		6.0	1.0	0.8	1.0	6.0
Physical sciences	0.0	0.1	0.0	0.2	0.2	0.2		0.2	0.2	0.1	0.2	0.1
Mathematics	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.1
Computer sciences	ΑĀ	Ϋ́	Ϋ́	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Life sciences	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Psychology	0.0	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.2
Social sciences	0.1	0.1	0.1	0.2	0.3	0.3		0.3	0.5	4.0	4.0	0.3
Engineering	0.0	0.0	0.1	0.0	0.0	0.1		0.0	0.1	0.1	0.1	0.1

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Appendix table 5-25.
Academic employment of doctoral scientists and engineers, by degree field, race/ethnicity, and type of position: 1973-95 (Thousands)

Field and race/ethnicity	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				Fu	Full-time faculty	'n						
All, total S&E	103.3	116.4	125.6	131.2	142.0	148.4	156.9	164.5	169.8	173.1	172.4	171.4
Total sciences	92.0	104.2	112.2	116.9	127.3	132.0	139.0	145.2	149.6	153.1	152.3	151.3
Physical sciences	17.8	18.9	20.0	20.0	20.5	20.2	21.2	22.0	21.5	21.7	21.3	20.9
Mathematics	9.3	10.4	10.9	11.4	11.7	12.3	12.7	12.9	13.5	14.2	14.7	13.0
Computer sciences	Ϋ́	Ϋ́	Ϋ́	0.1	0.3	4.0	0.7	6.0	1.3	1.8	2.3	2.8
Environmental sciences	3.0	3.4	3.6	3.5	3.8	4.0	4.2	4.4	4.7	4.5	4.5	4.7
Life sciences	29.5	33.1	34.9	37.3	40.9	43.5	45.6	48.1	49.3	51.1	50.8	52.8
Psychology	10.8	12.8	13.9	14.3	16.4	17.3	18.5	19.2	20.2	20.7	19.5	20.1
Social sciences	21.6	25.5	28.8	30.4	33.7	34.4	36.1	37.7	39.0	39.0	39.2	37.1
Engineering	11.3	12.2	13.5	14.3	14.7	16.4	17.9	19.3	20.2	20.1	20.2	20.0
White non-Hispanic, total S&E	94.9	106.2	114.3	118.7	128.1	133.4	139.7	146.2	149.8	151.8	148.7	147.1
Total sciences	85.0	92.6	102.6	106.5	115.4	119.4	124.9	130.4	133.6	135.7	133.1	131.7
Physical sciences	16.1	17.2	18.0	18.0	18.5	17.8	18.8	19.3	18.9	18.9	18.0	17.8
Mathematics	8.5	9.5	6.6	10.1	10.3	10.9	11.1	11.4	11.7	12.2	12.3	10.7
Computer sciences	Ϋ́	Ϋ́	Ϋ́	0.0	0.2	0.3	0.5	0.7	1.0	1.3	1.5	1.9
Environmental sciences	2.9	3.3	3.5	3.3	3.6	3.8	4.0	4.1	4.4	4.3	4.2	4.3
Life sciences	27.5	30.4	32.1	33.9	37.2	39.7	41.3	43.4	44.4	46.0	45.1	46.7
Psychology	10.3	12.1	13.0	13.6	15.4	16.2	17.1	17.9	18.8	19.2	18.0	18.4
Social sciences	19.7	23.2	26.1	27.5	30.2	30.7	32.2	33.6	34.4	33.8	34.1	31.9
Engineering	10.0	10.6	11.6	12.2	12.7	14.0	14.8	15.9	16.2	16.2	15.6	15.3
Asian, total S&E	4.0	4.7	2.0	7.8	8.4	9.5	10.9	11.7	12.4	12.7	14.9	14.5
Total sciences	3.0	3.7	3.9	0.9	8.9	7.2	8.2	8.8	9.0	9.6	11.2	11.0
Physical sciences	0.7	0.8	6.0	1.3	1.2	1.5	1.6	1.8	1.7	1.7	2.2	2.0
Mathematics	0.4	0.5	0.5	8.0	6.0	1.0	1.1	- -	1.3	1.5	1.7	1.6
Computer sciences	Ϋ́	Ϋ́	Υ V	0.0	0.0	0.1	0.1	0.1	0.3	0.5	0.7	0.8
Environmental sciences	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3
Life sciences	6:0	1.2	1.3	2.1	2.3	2.4	2.8	3.1	3.1	3.0	3.7	3.5
Psychology	0.1	0.1	0.1	0.2	0.3	0.3	0.3	4.0	0.4	9.4	9.4	9.4
Social sciences	6.0	. .	- -	1.5	1.9	1.9	2.1	2.1	2.2	2.4	2.3	2.5
Engineering	6.0	1.0	- -	1.8	1.7	1.9	2.7	3.0	3.4	3.1	3.7	3.6
Underrep. minorities, total S&Ea	2.1	2.7	3.3	4.3	5.2	5.6	5.9	6.5	7.6	8.7	9.5	10.0
Total sciences	1.9	2.5	3.0	4.0	4.9	5.5	5.5	0.9	7.0	7.9	8.3	8.9
Physical sciences	0.4	0.4	4.0	9.0	8.0	6.0	0.7	8.0	6.0	1.	1.2	[:
Mathematics	0.2	0.2	0.2	9.4	4.0	9.4	0.5	0.5	0.5	0.5	0.7	0.7
Computer sciences	Ϋ́	Ϋ́	ΑN	0.0	0:0	0.0	0.0	0.0	0.1	0.1	0.1	0.2
Environmental sciences	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Life sciences	0.7	0.0	1.0	- .	4.	1 .	1.5	1.7	1.9	2.1	2.1	5.6
Psychology	0.2	0.3	0.5	4.0	9.0	8.0	6.0	0.9	1.0	1.2	- .	4. (
Social sciences	4.0	0.6	8.0	1.4	1.6	1.7	æ. ∙	2.0	2.5	2.9	2.9	. v
Engineering	0.1	0.2	0.3	0.3	0.3	0.4	0.4	0.5	9.0	0.8	6.0	1.1
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Appendix table 5-25. Academic employment of doctoral scientists and engineers, by degree field, race/ethnicity, and type of position: 1973-95 (Thousands)

Field and race/ethnicity	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
Black, total S&E	1.2	1.4	1.5	1.7	2.3	5.6	2.7	2.9	3.2	4.1	3.9	4.8
Total sciences	-	£.	<u>۔</u> بر	9	00	4 6	90	2.7	0	3.7	9	4.3
) c) c) c	i c	- c	ic) c	;) -	: c
Tilysical sciences	7 7	7.0	7 .	7.7	7 7	. o		7.0	S. 0			
Mathematics	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2
Computer sciences	Ϋ́	Ϋ́	ΑN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Life sciences	0.3	0.5	0.5	0.5	0.5	9.0	0.7	0.7	0.8	1.0	1.0	1.3
Peychology		00	6	0.0	0.4	0.4	20	ני	90	2.0	90	90
Social sciences	. « . c	7.0) 	i.O	; o) -) -) -	. r	5 -	
	5 5	i c	; ;	9 5	2 5	9 0) c	- 0	- c	† 0 - C	
	-	- -	0.0	-	-	0.2	- -	0.Z	0.2	4.	ر د:	C.O
Hispanic, total S&E	0.7	1.0	1.3	2.0	2.1	2.2	2.4	2.7	3.3	3.7	3.9	4.4
Total sciences	9.0	0.9	1.2	1.7	2.0	2.0	2.2	2.5	3.0	3.3	3.5	3.8
Physical sciences	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.5	0.4	9.0	9.0	0.5
Mathematics	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4
Computer sciences	Ą	₹	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1
Environmental sciences	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Life sciences	0.3	0.4	0.4	0.5	0.7	9.0	9.0	8.0	6.0	6.0	6.0	1.2
Psychology	0.1	0.1	0.1	0.1	0.2		0.3	8.0	0.3	0.3	4.0	0.5
Social sciences		0	00		, C	, C	5.0	2.0	000			
Fnoineering		10	i 0	000	0.0	0:0	0.0) C	5.0	00 4.0	9:0
, n		;	!	!		!	ļ Š))	5)
Native American, total S&E	0.2	0.3	9.4	9.0	0.7	0.8	0.8	6.0	1.0	9.0	6.0	0.8
Total sciences	0.2	0.3	0.3	9.0	0.7	0.7	0.7	8.0	6.0	9.0	8.0	0.7
Physical sciences	0.0	0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Mathematics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Computer sciences	Ν Α	Ϋ́	A A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Life sciences	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2
Psychology	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Social sciences	0.1	0.1	0.1	0.2	0.3	0.3	0.2	0.3	0.4	4.0	0.4	
Engineering	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1
			Full-time non	III-time nonfaculty, part-time, and postdoctorate positions	t-time, and p	ostdoctora	te positions					
All, total S&E	14.7	17.8	19.9	24.1	25.2	27.8	33.4	31.5	36.9	37.4	41.4	46.2
Total sciences	13.6	16.5	18.5	22.6	23.7	26.1	31.4	29.6	34.3	34.7	38.4	42.4
Physical sciences	4.2	4.6	4.9	4.7	4.8	5.0	5.8	5.2	6.2	6.0	7.4	8.5
Mathematics	0.4	0.6	0.8	0.8	0.7	0.7	0.8	6.0	1.0	1.0	0.8	1.6
Computer sciences	ΑN	Ϋ́	Ϋ́	0.0	0.0	0.1	0.1	0.2	0.2	0.1	0.2	0.3
Environmental sciences	0.4	0.5	9.0	0.7	0.8	0.8	1.0	1.2	1.2	1.5	1.9	1.7
Life sciences	5.4	6.3	7.7	9.7	10.4	11.4	13.1	13.1	15.5	15.8	17.4	18.8
Psychology	1.4	1.9	2.3	3.4	3.7	3.7	4.6	4.5	4.8	4.4	5.5	6.1
Social sciences	1.8	2.5	2.3	3.3	3.2	4.4	5.8	4.5	5.5	5.8	5.2	5.4
Engineering	1.1	1.2	1.3	1.5	4.1	1.7	2.0	1.9	5.6	2.7	3.0	3.8

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Appendix table 5-25. Academic employment of doctoral scientists and engineers, by degree field, race/ethnicity, and type of position: 1973-95 (Thousands)

Field and race/ethnicity	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
		. !	!		;			1				
White non-Hispanic, total S&E	12.9	15.4	17.2	21.3	21.9	23.9	28.8	26.7	31.3	31.7	33.1	35.5
Total sciences	12.0	14.4	16.2	20.1	20.5	22.7	27.2	25.4	29.4	29.7	31.2	33.2
Physical sciences	3.6	4.0	4.1	3.9	3.9	4.1	4.7	4.0	4.8	4.9	5.4	0.9
Mathematics	0.4	9.0	0.7	0.7	9.0	9.0	0.8	0.8	6.0	0.8	9.0	1.3
Computer sciences	Α	Ϋ́	ΑN	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.2	0.2
Environmental sciences	0.4	0.4	0.5	2.0	0.7	0.8	6.0	1.1	1.0	1.4	1.7	1.4
Life sciences	4.7	5.4	6.7	8.5	8.9	9.7	11.4	11.3	13.2	13.2	14.0	14.6
Psychology	1.3	1.8	2.2	3.2	3.4	3.4	4.2	4.1	4.4	4.0	4.9	5.2
Social sciences	1.6	2.2	2.0	3.0	3.0	4.0	5.1	4.0	5.0	5.3	4.5	4.7
Engineering	8.0	1.0	1.0	1.3	1.4	1.2	1.7	1.3	1.9	2.0	1.9	2.3
Asian, total S&E	[:	1.5	1.7	2.1	2.5	2.7	3.2	3.3	4.0	4.2	6.1	8.0
Total sciences	1.0	1.3	1.5	1.9	2.4	2.2	2.9	2.8	3.3	3.6	5.1	9.9
Physical sciences	0.5	0.5	9.0	9.0	0.8	0.7	1.0	1.0	1.	0.0	1.6	2.1
Mathematics	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.2
Computer sciences	Α	Ϋ́	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.3
Life sciences	0.4	9.0	0.8	1.0	4.	1.2	6.	1.4	1.7	2.1	2.7	3.4
Psychology	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Social sciences	0.0	0.1	0.1	0.2	0.1	0.1	0.4	0.2	0.2	0.2	0.3	0.3
Engineering	0.1	0.1	0.2	0.2	0.1	0.4	0.3	0.5	0.7	9.0	1.0	1.3
Underrep. minorities, total S&E ^a	0.4	0.5	0.5	0.7	0.8	7:	4.1	1.5	1.7	1.5	2.3	2.8
Total sciences	0.3	0.5	0.5	9.0	0.8	1.0	1.3	4.1	1.6	1.4	2.2	2.7
Physical sciences	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.2	4.0	0.4
Mathematics	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.2
Computer sciences	ΑΝ	Ϋ́	Ν	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Life sciences	0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.5	9.0	0.5	0.8	6.0
Psychology	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.7
Social sciences	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4
Engineering	0.0	0:0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Black, total S&E	0.2	0.3	0.3	0.3	0.4	9.0	9.0	0.7	9.0	9.0	1.0	1.3
Total sciences	0.2	0.3	0.2	0.3	0.4	9.0	9.0	0.7	0.5	0.5	1.0	1.3
Physical sciences	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1
Mathematics	0:0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Computer sciences	ΑĀ	ΑN	ΑN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Life sciences	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	4.0
Psychology	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.1	0.3	4.0
Social sciences	0:0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.2
Engineering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Academic employment of doctoral scientists and engineers, by degree field, race/ethnicity, and type of position: 1973-95 Appendix table 5-25. (Thousands)

Field and race/ethnicity	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
Hispanic, total S&E	0.2	0.2	0.3	0.4	0.4	9.0	0.7	2.0	1.0	0.8	1.0	1.3
Total sciences	0.2	0.2	0.2	0.3	0.4	0.4	9.0	9.0	6.0	0.8	6.0	1.2
Physical sciences	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2
Mathematics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Computer sciences	Ϋ́	ΑN	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Life sciences	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.4	0.3	0.4	0.4
Psychology	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2
Social sciences	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.2	0.1
Engineering	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1
Native American, total S&E	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2
Total sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.2
Physical sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Mathematics	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Computer sciences	Ϋ́	ΑN	Ϋ́	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Life sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Psychology	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Social sciences	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Engineering	0.0	0.0	0.0	0.0	0.0	0.0	0:0	0:0	0.0	0.0	0.0	0.0

NA = not available

NOTES: Data exclude university-managed federally funded research and development centers. Due to survey coverage, the data also exclude scientists and engineers with doctorates from foreign institutions. Field of employment data were discontinued after the 1991 survey and are not shown. Faculty positions include full, associate, and assistant professors and instructors. Details may not add to totals because of rounding and the inclusion of Hispanic respondents in different racial categories.

^aUnderrepresented minorities in science and engineering are blacks, Hispanics, and Native Americans.

SOURCE: National Science Foundation, Science Resources Studies Division, Characteristics of Doctoral Scientists and Engineers in the United States: 1995, Detailed Statistical Tables, NSF 97-333

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(Arlington, VA: 1997).

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Appendix table 5-26. Age distribution of academic doctoral scientists and engineers, by type of appointment: 1973-95 (Percentages)

	Total	35 and younger	36-45 years old	46-55 years old	56-65 years old	65 and older
		All doctoral scient	tists and engineer	rs		
1973	100.0	33.0	33.4	22.1	9.9	1.6
1975	100.0	30.7	34.8	22.7	10.3	1.5
1977	100.0	28.6	36.1	22.7	11.2	1.4
1979	100.0	24.0	39.0	23.1	12.2	1.6
1981	100.0	22.4	39.3	22.5	13.8	2.1
1983	100.0	18.6	40.5	23.9	14.4	2.6
1985	100.0	17.4	39.8	25.2	14.7	2.8
1987	100.0	15.9	37.6	28.5	15.2	2.8
1989	100.0	15.2	34.9	31.0	15.8	3.1
1991	100.0	14.8	34.3	32.4	15.7	2.8
1993	100.0	16.3	33.9	32.8	14.8	2.3
1995	100.0	15.7	33.2	32.8	15.7	2.6
		Full-time	e faculty			
1973	100.0	30.4	34.6	23.2	10.2	1.5
1975	100.0	27.8	36.2	23.9	10.6	1.5
1977	100.0	25.2	37.3	24.2	11.9	1.4
1979	100.0	20.2	40.2	24.8	13.1	1.7
1981	100.0	18.5	40.3	24.3	14.8	2.2
1983	100.0	14.8	41.1	25.8	15.7	2.6
1985	100.0	14.1	40.3	27.0	15.9	2.8
1987	100.0	12.1	37.6	30.7	16.8	2.9
1989	100.0	10.9	34.7	33.7	17.6	3.0
1991	100.0	11.6	33.6	34.9	17.1	2.8
1993	100.0	11.9	33.8	35.4	16.4	2.5
1995	100.0	10.9	32.8	35.7	17.8	2.8
		All other types	of appointment			
1973	100.0	54.6	23.3	12.9	6.8	2.4
1975	100.0	52.0	24.3	14.1	7.6	1.9
1977	100.0	53.9	27.0	11.3	6.1	1.7
1979	100.0	49.7	31.2	11.6	6.2	1.3
1981	100.0	47.5	32.8	11.5	7.1	1.2
1983	100.0	43.0	36.8	11.6	5.9	2.7
1985	100.0	35.4	37.5	15.6	8.3	3.1
1987	100.0	38.7	37.5	15.6	6.0	2.3
1989	100.0	37.6	35.9	17.0	6.4	3.1
1991	100.0	30.9	37.4	19.9	8.7	3.0
1993	100.0	35.8	34.1	21.5	7.3	1.4
1995	100.0	35.4	35.1	20.6	7.0	1.8

NOTES: Faculty positions include full, associate, and assistant professors and instructors. Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations (1997).

See figure 5-12.

Appendix table 5-27. Age distribution of full-time doctoral S&E faculty at research universities and other academic institutions: 1973-95

Age bracket	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				All unive	All universities and c	colleges						
Total number (thousands)	103.3	116.4	125.6	131.2	142.0	148.4	156.9	164.5	169.8	173.1	172.4	171.4
Under 30 (%)	7.1	5.0	4.5	3.4	3.1	2.2	1.9	1.3	1.5	1.5	2.1	1.6
31-35 (%)	23.2	22.8	20.5	16.7	15.2	12.5	12.0	10.5	9.4	10.2	9.8	0.6
36-40 (%)	18.8	20.2	21.8	23.4	21.5	19.8	19.0	17.1	16.1	15.4	16.0	15.7
41-45 (%)	16.1	16.3	15.6	16.8	19.0	21.7	21.7	20.6	18.7	18.4	17.5	17.0
46-50 (%)	13.1	13.0	13.6	13.6	13.1	14.1	15.4	18.7	20.7	19.6	19.1	17.5
51-55 (%)	10.2	10.9	10.9	11.6	11.5	12.1	11.9	12.3	13.4	15.6	16.4	18.4
56-60 (%)	6.3	9.9	7.7	8.2	9.2	9.6	9.1	10.2	10.5	10.5	6.6	11.3
61-65 (%)	3.9	4.0	4.3	4.9	5.6	6.1	9.9	6.5	7.1	6.4	6.7	9.9
(%) +99	1.3	1.2	- -	1.4	1.8	2.0	2.4	2.7	2.7	2.4	2.5	2.8
				Resea	Research universities	ities						
Total number (thousands)	55.7	61.4	64.7	67.1	73.8	72.2	90.8	84.2	9.98	82.8	84.3	81.6
Under 30 (%)	6.7	4.9	4.6	3.9	4.2	2.8	2.5	1.6	1.9	1.5	2.3	1.6
31-35 (%)	21.7	21.6	19.3	17.3	15.4	12.8	13.4	12.4	11.0	11.4	11.1	9.4
36-40 (%)	18.2	19.1	20.2	20.7	20.5	19.4	18.3	17.0	17.5	17.3	17.4	17.5
41-45 (%)	16.4	15.8	14.8	16.8	17.6	19.2	19.7	19.1	17.2	17.4	17.2	17.9
46-50 (%)	13.7	13.7	14.4	13.6	12.5	13.8	14.6	17.1	17.6	18.1	17.8	16.2
51-55 (%)	10.7	11.9	11.9	12.2	11.3	11.9	11.9	11.5	13.1	14.2	14.5	16.0
26-60 (%)	6.9	7.2	8.5	8.8	10.1	10.5	9.5	10.4	10.6	10.5	8.6	11.3
61-65 (%)	4.4	4.5	5.1	5.2	6.2	7.2	7.7	9.7	9.7	9.9	7.0	6.7
(%) +99	1.4	1.4	1.3	1.6	2.2	2.3	2.7	3.3	3.5	3.1	5.9	3.5
			Oŧ	Other types of	universities	and college:	S					
Total number (thousands)	47.6	54.9	6.09	64.2	68.2	76.2	26.3	80.2	83.2	87.2	88.1	89.7
Under 30 (%)	9.7	5.1	4.3	2.8	2.0	1.7	1.3	1.0	1.0	1.5	1.8	1.6
31-35 (%)	24.9	24.0	21.9	16.1	14.9	12.1	10.5	8.6	7.7	0.6	8.6	8.6
36-40 (%)	19.6	21.4	23.6	26.3	22.7	20.1	19.7	17.3	14.6	13.6	14.8	14.2
41-45 (%)	15.7	16.8	16.5	16.8	20.5	24.1	23.8	22.1	20.2	19.3	17.9	16.2
46-50 (%)	12.5	12.3	12.8	13.7	13.6	14.4	16.1	20.5	23.8	21.1	20.4	18.8
51-55 (%)	9.5	9.8	9.8	11.0	11.7	12.3	11.9	13.0	13.8	17.0	18.2	20.5
26-60 (%)	2.7	5.9	6.8	9.7	8.3	8.6	8.9	6.6	10.5	10.6	6.6	11.4
61-65 (%)	3.2	3.5	3.5	4.6	4.9	5.0	5.6	5.4	6.5	6.2	6.3	6.5
(%) +99	1.3	- -	8.0	1.1	1.3	1.6	2.1	2.1	1.8	1.7	2.1	2.2
NOTE OF Property of the Control of t	0 0 0	4000	1000	00:10:1	400	10.0	300	-				

NOTES: Faculty positions include full, associate, and assistant professors and instructors. Italics = rounded numbers; all other numbers are percentages.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations (1997).

See figure 5-13.

^{*}Research universities are designated by Carnegie classification code (see Carnegie Foundation for the Advancement of Teaching, A Classification of Institutions of Higher Education, 1994 ed., Princeton: Princeton University Press, 1994).

Appendix table 5-28. **Employment sector of recent S&E Ph.D.s, by sex and race/ethnicity: 1973-95** (Thousands)

Sector	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				A	II recent	S&E Ph.D.	.s					
Total	45.4	45.0	43.2	40.7	42.0	42.7	43.8	44.8	47.8	53.6	49.7	52.1
Academia	25.0	23.4	22.5	20.9	20.7	20.5	21.8	21.1	23.3	25.5	25.1	26.9
Business	8.6	9.9	9.0	8.8	11.6	12.0	11.5	9.5	10.6	12.7	12.4	13.6
Government	4.5	4.3	4.1	3.9	3.3	3.7	3.2	3.4	3.3	3.5	4.0	4.1
FFRDCs	2.1	2.0	1.9	1.6	1.3	0.8	1.6	1.5	1.6	2.2	2.1	1.6
All other	5.1	5.4	5.6	5.5	5.1	5.5	5.7	9.2	9.0	9.5	6.1	5.9
					М	en						
Total	40.8	39.1	36.4	33.2	32.6	32.3	32.2	32.2	34.0	37.0	33.9	34.0
Academia	21.9	19.5	18.2	16.4	15.5	14.7	15.5	14.9	16.1	16.7	16.8	16.7
Business	8.4	9.5	8.3	7.9	10.0	10.0	9.4	8.0	8.7	10.3	9.6	10.5
Government	4.2	3.9	3.6	3.3	2.6	2.9	2.4	2.4	2.4	2.6	2.6	2.6
FFRDCs	2.0	1.9	1.8	1.5	1.2	0.7	1.4	1.3	1.4	1.9	1.6	1.2
All other	4.2	4.4	4.4	4.0	3.4	3.8	3.4	5.6	5.4	5.4	3.2	3.0
					Wo	men						
Total	4.6	5.8	6.8	7.5	9.4	10.4	11.6	12.6	13.8	16.6	15.8	18.1
Academia	3.1	3.9	4.3	4.5	5.2	5.8	6.3	6.2	7.3	8.8	8.3	10.2
Business	0.3	0.4	0.7	0.9	1.6	2.0	2.1	1.6	1.9	2.4	2.8	3.0
Government	0.3	0.4	0.5	0.6	0.7	0.9	0.8	1.0	0.9	0.9	1.4	1.5
FFRDCs	0.0	0.1	0.1	0.1	0.2	0.1	0.2	0.3	0.2	0.3	0.5	0.4
All other	0.8	1.0	1.3	1.4	1.7	1.7	2.3	3.6	3.6	4.1	2.9	3.0
					Wh	ites						
Total	40.6	38.5	36.4	34.4	35.3	35.4	36.1	36.2	37.3	40.2	36.1	35.9
Academia	22.8	20.4	19.5	18.1	18.0	17.3	18.1	17.2	18.3	19.5	18.0	18.8
Business	7.4	7.9	6.9	6.7	8.9	9.4	9.2	7.4	7.9	8.5	7.8	8.2
Government	4.2	3.8	3.6	3.5	2.9	3.3	2.6	2.9	2.8	2.9	3.4	3.2
FFRDCs	1.9	1.8	1.6	1.3	1.1	0.7	1.5	1.4	1.3	1.9	1.7	1.2
All other	4.4	4.5	4.8	4.7	4.3	4.5	4.7	7.2	7.0	7.3	5.2	4.6
					Asi	ans						
Total	2.8	4.1	4.5	4.2	4.8	4.9	5.2	6.0	7.5	9.9	10.6	12.6
Academia	1.2	1.6	1.7	1.6	1.7	2.1	2.4	2.5	3.3	4.1	5.4	6.2
Business	1.0	1.6	1.8	1.8	2.4	2.1	1.8	1.7	2.3	3.5	3.9	4.7
Government	0.2	0.2	0.2	0.2	0.2	0.1	0.4	0.2	0.3	0.4	0.4	0.6
FFRDCs	0.1	0.1	0.2	0.2	0.2	0.0	0.1	0.1	0.2	0.3	0.3	0.4
All other	0.4	0.5	0.6	0.5	0.5	0.6	0.5	1.4	1.3	1.6	0.6	0.8
				Unde	rrepreser	nted mino	ritiesª					
Total	1.0	1.6	1.7	2.0	1.8	2.3	2.3	2.5	3.0	3.4	3.0	3.5
Academia	0.6	0.9	1.0	1.1	0.9	1.1	1.2	1.3	1.7	1.8	1.7	1.9
Business	0.1	0.2	0.2	0.3	0.2	0.5	0.4	0.4	0.4	0.7	0.6	0.7
	0.4	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
Government	0.1	0.1										
Government	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0

FFRDC = federally funded research and development center

NOTES: Recent Ph.D.s are those who have earned their doctorate within the three preceding years. Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations (1997).

^aUnderrepresented minorities in science and engineering are blacks, Hispanics, and Native Americans. Data on race/ethnicity exclude unknown cases and do not add to total.

Appendix table 5-29. **Recent S&E Ph.D.s** employed in higher education, by field and type of appointment: 1973-95 (Thousands)

Appointment	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				S	cience &	engineerii	ng					
Total	25.0	23.4	22.5	20.9	20.7	20.5	21.8	21.1	23.3	25.5	25.1	26.9
Faculty	18.8	16.8	15.0	12.8	12.0	11.8	12.5	11.0	11.4	14.4	12.4	11.6
Postdoctorate	3.2	4.3	5.2	5.2	5.9	5.7	6.0	6.3	7.8	7.0	8.4	10.7
Other	2.1	1.5	1.4	2.6	2.6	2.3	3.0	3.5	3.7	3.4	4.3	4.6
					Physical	sciences						
Total	4.1	3.1	3.0	2.2	2.2	2.0	2.5	2.4	2.9	2.9	3.4	3.8
Faculty	1.9	1.2	1.2	8.0	0.7	0.6	0.8	0.7	8.0	1.0	0.9	0.7
Postdoctorate	1.3	1.4	1.5	1.1	1.3	1.1	1.5	1.4	1.7	1.4	2.1	2.4
Other	0.6	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.3	0.6
					Mathe	matics						
Total	2.3	1.9	1.8	1.3	1.1	1.1	1.1	1.1	1.1	1.6	1.6	1.2
Faculty	2.2	1.7	1.5	1.2	1.0	1.0	1.0	0.8	0.9	1.3	1.4	8.0
Postdoctorate	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.3
Other	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.1	0.2
					Compute	r sciences	S					
Total	NA	NA	NA	0.1	0.3	0.2	0.4	0.5	0.6	0.7	0.7	0.8
Faculty	NA	NA	NA	0.1	0.2	0.2	0.3	0.4	0.6	0.7	0.6	0.6
Postdoctorate	NA	NA	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Other	NA	NA	NA	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1
				En	vironmen	ital scienc	es					
Total	0.7	0.8	0.7	0.6	0.6	0.6	0.6	8.0	0.6	0.7	0.7	0.9
Faculty	0.5	0.6	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.2	0.3
Postdoctorate	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.4
Other	0.1	0.1	0.0	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2
					Life so	iences						
Total	7.1	6.9	6.6	6.7	7.3	7.4	7.4	7.4	8.2	9.0	8.8	10.2
Faculty	4.6	4.0	3.2	2.8	2.9	3.1	2.8	2.6	2.5	3.4	2.5	3.0
Postdoctorate	1.5	2.2	2.8	3.2	3.6	3.5	3.4	3.6	4.4	4.4	4.8	5.6
Other	0.6	0.4	0.4	0.7	0.8	0.7	1.0	1.0	1.2	0.9	1.5	1.5
					Psych	nology						
Total	2.6	2.8	3.0	3.1	2.9	2.7	3.0	2.7	2.9	2.8	2.6	2.9
Faculty	2.2	2.3	2.3	2.0	1.7	1.8	1.7	1.4	1.5	1.8	1.4	1.5
Postdoctorate	0.1	0.3	0.3	0.4	0.5	0.3	0.5	0.4	0.6	0.3	0.2	0.7
Other	0.2	0.2	0.2	0.6	0.6	0.4	0.7	8.0	8.0	0.6	1.0	8.0
					Social s	ciences						
Total	5.8	5.9	5.5	5.3	4.9	4.5	4.6	4.0	4.0	4.5	4.3	4.0
Faculty	5.5	5.4	5.0	4.5	4.0	3.5	3.6	3.1	2.8	3.7	3.4	3.1
Postdoctorate	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.0	0.2	0.1	0.1	0.2
Other	0.2	0.3	0.3	0.5	0.7	0.5	0.8	0.8	0.9	0.6	0.8	0.7
					Engin	eering						
Total	2.4	1.9	1.9	1.6	1.4	2.0	2.3	2.3	3.0	3.3	3.0	3.2
Faculty	2.0	1.5	1.4	1.2	1.2	1.4	1.9	1.6	2.0	2.3	1.9	1.6
Postdoctorate	0.1	0.2	0.3	0.2	0.2	0.3	0.2	0.4	0.5	0.4	0.7	1.0
Other	0.3	0.2	0.1	0.3	0.1	0.2	0.1	0.3	0.4	0.5	0.4	0.6

NOTES: Recent Ph.D.s are those who have earned their doctorate within the three preceding years. Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations (1997).

See figure 5-15.

Appendix table 5-30. Recent S&E Ph.D.s employed in higher education, by sex, race/ethnicity, and type of appointment: 1973-95 (Thousands)

Appointment	1973	1975	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995
				4	All recent s	S&E Ph.D.	.s					
Total	25.0	23.4	22.5	20.9	20.7	20.5	21.8	21.1	23.3	25.5	25.1	26.9
Faculty	18.8	16.8	15.0	12.8	12.0	11.8	12.5	11.0	11.4	14.4	12.4	11.6
Postdoctorate	3.2	4.3	5.2	5.2	5.9	5.7	6.0	6.3	7.8	7.0	8.4	10.7
Other	2.1	1.5	1.4	2.6	2.6	2.3	3.0	3.5	3.7	3.4	4.3	4.6
					М	en						
Total	21.9	19.5	18.2	16.4	15.5	14.7	15.5	14.9	16.1	16.7	16.8	16.7
Faculty	16.7	14.2	12.3	10.0	9.2	8.8	9.0	7.9	7.9	9.6	8.3	7.0
Postdoctorate	2.8	3.4	4.2	4.1	4.4	4.1	4.2	4.7	5.7	4.7	6.0	6.9
Other	1.6	1.2	1.1	2.1	1.8	1.5	2.0	2.2	2.2	1.9	2.5	2.8
					Woi	men						
Total	3.1	3.9	4.3	4.5	5.2	5.8	6.3	6.2	7.3	8.8	8.3	10.2
Faculty	2.1	2.6	2.8	2.8	2.8	3.0	3.5	3.2	3.5	4.8	4.1	4.6
Postdoctorate	0.4	8.0	1.0	1.1	1.5	1.6	1.7	1.6	2.2	2.3	2.4	3.7
Other	0.4	0.3	0.3	0.5	0.8	8.0	1.1	1.3	1.5	1.5	1.9	1.9
					Wh	ites						
Total	22.8	20.4	19.5	18.1	18.0	17.3	18.1	17.2	18.3	19.5	18.0	18.8
Faculty	17.3	14.9	13.3	11.1	10.7	10.1	10.4	9.2	9.2	11.3	9.2	9.0
Postdoctorate	2.8	3.4	4.2	4.4	4.8	4.8	4.9	4.9	5.9	4.8	5.4	6.6
Other	1.9	1.3	1.2	2.3	2.3	1.8	2.6	3.0	2.9	2.7	3.5	3.2
					Asi	ans						
Total	1.2	1.6	1.7	1.6	1.7	2.1	2.4	2.5	3.3	4.1	5.4	6.2
Faculty	0.6	0.7	0.7	8.0	0.5	1.0	1.3	1.0	1.3	1.8	2.1	1.7
Postdoctorate	0.3	0.7	0.8	0.6	0.9	0.7	0.8	1.1	1.4	1.8	2.6	3.5
Other	0.1	0.1	0.1	0.2	0.2	0.4	0.3	0.3	0.4	0.5	0.6	1.0
				Unde	rrepreser	ted mino	ritiesª					
Total	0.6	0.9	1.0	1.1	0.9	1.1	1.2	1.3	1.7	1.8	1.7	1.9
Faculty	0.4	8.0	8.0	0.9	0.7	0.7	0.7	0.7	0.9	1.3	1.0	0.9
Postdoctorate	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.3	0.4	0.6
Other	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.3	0.4

NOTES: Recent Ph.D.s are those who have earned their doctorate within the three preceding years. Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Doctorate Recipients, unpublished tabulations (1997).

See figure 5-15.

^aUnderrepresented minorities in science and engineering are blacks, Hispanics, and Native Americans.

Appendix table 5-31. **Academic doctoral scientists and engineers, by self-reported primary work responsibility and type of employing institution: 1973-95**(Thousands)

	All ac	ademic institu	tions	Res	earch universi	tiesª	Other uni	versities and o	olleges
	Teaching	Research	Other	Teaching	Research	Other	Teaching	Research	Other
			Nu	mber (thousa	nds)				
1973	73.3	27.8	16.9	32.3	17.5	7.8	41.0	10.3	9.2
1975	83.9	30.8	19.4	36.5	19.0	7.8	47.3	11.8	11.6
1977	82.2	37.0	26.3	33.3	21.9	12.4	48.9	15.1	13.8
1979	83.9	41.3	30.2	33.6	23.3	14.4	50.3	17.9	15.9
1981	95.9	46.5	24.6	39.6	28.1	10.8	56.3	18.4	13.8
1983	97.7	48.9	29.6	36.2	28.2	12.7	61.5	20.6	16.9
1985	101.1	56.0	33.3	37.4	34.9	13.2	63.7	21.1	20.1
1987	99.4	66.5	30.1	35.1	42.5	13.6	64.2	24.0	16.5
1989	101.0	72.2	33.6	34.4	45.0	14.4	66.5	27.2	19.1
1991	103.4	73.9	33.2	33.5	45.9	14.1	69.9	28.1	19.2
1993	98.3	80.2	35.2	31.6	46.5	14.7	66.8	33.7	20.5
1995	100.2	83.0	34.3	30.5	45.9	13.7	69.7	37.1	20.7
				Percent					
1973	62	24	14	56	30	13	68	17	15
1975	63	23	14	58	30	12	67	17	16
1977	57	25	18	49	32	18	63	19	18
1979	54	27	19	47	33	20	60	21	19
1981	57	28	15	50	36	14	64	21	16
1983	55	28	17	47	37	16	62	21	17
1985	53	29	17	44	41	15	61	20	19
1987	51	34	15	38	47	15	61	23	16
1989	49	35	16	37	48	15	59	24	17
1991	49	35	16	36	49	15	60	24	16
1993	46	38	16	34	50	16	55	28	17
1995	46	38	16	34	51	15	55	29	16

NOTE: Details may not add to totals because of rounding.

^aResearch universities are designated by Carnegie classification code (see Carnegie Foundation for the Advancement of Teaching, *A Classification of Institutions of Higher Education*, 1994 ed., Princeton: Princeton University Press, 1994).

SOURCE: National Science Foundation, Survey of Doctorate Recipients, unpublished tabulations (1997).

Science & Engineering Indicators – 1998

Appendix table 5-32. Academic doctoral scientists and engineers with work responsibility for R&D, by degree field: 1973-95

i i	010	100	7071	010	700	000		1	000	700	000	100
Fleid	1973	1975	13/1	1979	1981	1983	1985	1987	1969	1881	1993	1880
				Total emp	Fotal employment (thousands)	ousands)						
Total science & engineering	118.0	134.1	145.5	155.4	167.1	176.2	190.3	196.0	206.7	210.6	213.8	217.5
Total sciences	105.6	120.7	130.7	139.5	151.0	158.1	170.4	174.8	183.9	187.8	190.6	193.7
Physical sciences	22.1	23.6	25.0	24.6	25.4	25.1	27.0	27.2	27.7	27.7	28.6	29.3
Mathematics	9.7	11.0	11.7	12.2	12.4	12.9	13.6	13.8	14.5	15.2	15.5	14.6
Computer sciences	Ϋ́	ΑΝ	ΑN	0.1	0.3	0.5	0.8		1.5	2.0	2.5	3.1
Environmental sciences	3.4	3.9	4.2	4.2	4.6	4.8	5.2	5.6	5.9	0.9	6.4	6.4
Life sciences	34.9	39.4	42.6	47.0	51.3	54.9	58.7	61.3	64.8	6.99	68.2	71.6
Psychology	12.2	14.8	16.2	17.7	20.1	21.0	23.1	23.7	25.0	25.2	25.0	26.1
Social sciences	23.4	28.0	31.1	33.6	36.9	38.9	42.0	42.2	44.5	44.8	44.4	42.5
Engineering	12.4	13.4	14.8	15.8	16.1	18.1	19.9	21.2	22.9	22.8	23.1	23.8
				Active in	n R&D (thou	sands)						
Total science & engineering	82.3	90.6	85.0	90.0	104.5	106.7	114.7	143.9	151.6	156.6	150.1	153.5
Total sciences	73.3	81.6	76.1	80.2	94.3	95.1	101.9	127.2	133.9	138.4	132.6	135.0
Physical sciences	16.3	16.9	16.3	15.4	16.8	16.3	17.5	20.2	20.8	20.8	20.0	20.6
Mathematics	6.8	7.5	6.8	6.9	7.3	7.7	7.7	9.7	10.2	10.7	9.5	9.4
Computer sciences	ΑN	ΑN	ΑN	0.1	0.3	0.4	0.5	1.0	1.3	1.7	2.0	2.4
Environmental sciences	2.5	2.8	2.9	2.7	3.3	3.3	3.8	4.6	4.9	5.1	5.0	5.1
Life sciences	26.0	29.0	28.7	32.1	36.7	38.2	39.6	48.8	51.8	53.3	51.8	53.8
Psychology	7.3	8.5	7.7	8.3	10.5	10.7	10.9	14.3	14.3	15.7	14.9	15.6
Social sciences	14.3	16.9	13.8	14.7	19.6	18.6	22.0	28.6	30.5	31.1	29.3	28.1
Engineering	9.0	9.0	8.9	8.6	10.2	11.6	12.8	16.7	17.7	18.2	17.5	18.5
				Percent	Percentage active i	in R&D						
Total science & engineering	20	89	28	58	63	61	09	73	73	74	70	71
Total sciences	69	89	58	22	62	09	09	73	73	74	20	20
Physical sciences	74	72	92	63	99	92	65	74	75	75	20	20
Mathematics	20	89	58	22	29	29	22	20	71	71	61	64
Computer sciences	Ϋ́	Ϋ́	A A	86	92	72	69	06	89	98	62	92
Environmental sciences	72	73	69	65	72	69	73	83	84	84	78	80
Life sciences	75	74	29	89	71	20	29	80	80	80	92	75
Psychology	09	22	48	47	52	51	47	09	22	62	09	09
Social sciences	61	09	44	44	53	48	52	89	89	69	99	99
Engineering	73	29	09	62	63	64	64	26	27	80	9/	78
NA = not available												

NA = not available

NOTES: Data exclude university-managed federally funded research and development centers. Due to survey coverage, the data also exclude scientists and engineers with doctorates from foreign institutions. All data are based on degree field. Those who are "active in R&D" reported a primary or secondary work responsibility for R&D. For 1981-87, counts are lower bound estimates because a fraction of academic respondents was not asked about secondary work responsibility (15 percent in 1981, 6 percent in 1983, 13 percent in 1985, and fewer than 1 percent in 1987). Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Science Resources Studies Division, Characteristics of Doctoral Scientists and Engineers in the United States: 1995, Detailed Statistical Tables, NSF 97-333 (Arlington, VA: 1997).

See figure 5-16.

Appendix table 5-33.

Academic doctoral scientists and engineers reporting federal support from one or more agencies, by field: 1973-95 (Percentages)

	1973	1975	1977	1979	1981	1983	1985ª	1987	1989	1991	1993*	1995ª
				Total sci	Total science & engineering	neering						
Total number employed	118,000	134,100	145,500	155,400	167,100	176,200	190,300	196,000	206,700	210,600	213,800	217,500
Percentage supported	46	42	41	39	42	44	37	48	49	20	37	39
Funding from 1 agency	80	80	81	82	81	80	82	74	74	20	75	73
Funding from 2 agencies	17	16	15	15	16	17	16	20	20	23	20	21
Funding from 3+ agencies	4	4	3	3	3	3	3	9	9	7	2	5
				ĭ	Fotal sciences	"						
Total number employed	105,600	120,700	130,700	139,600	151,000	158,100	170,400	174,800	183,800	187,800	190,700	193,700
Percentage supported	45	4	40	38	41	43	36	47	48	49	36	38
Funding from 1 agency	81	81	82	83	82	81	82	75	75	72	9/	75
Funding from 2 agencies	16	16	5 .	1 c	5 0	17	15	20	19 4	22	19	20
alidilig lidili of agelides	2	2	2	7	2		0	ס	כ	0	ס	ס
				P.	Physical sciences	es						
Total number employed	22,100	23,600	25,000	24,600	25,400	25,100	27,000	27,200	27,700	27,700	28,600	29,300
Percentage supported	49	45	46	44	20	51	43	54	58	26	46	48
Funding from 1 agency	77	75	77	77	92	74	78	89	69	63	89	99
Funding from 2 agencies	20	21	19	20	17	23	18	24	24	30	26	28
Funding from 3+ agencies	က	4	4	ဇ	7	က	တ	80	7	7	9	7
				_	Mathematics							
Total number employed	9,700	11,000	11,700	12,200	12,400	12,900	13,600	13,800	14,500	15,200	15,500	14,600
Percentage supported	29	19	19	21	21	30	21	31	33	34	19	22
Funding from 1 agency	06	88	88	86	83	88	84	78	74	75	80	75
Funding from 2 agencies	80	10	=	14	15	о	15	19	22	19	16	21
Funding from 3+ agencies	2	-	-	0	2	2	1	က	4	9	4	3
				Con	Computer sciences	sec						
Total number employed	Α	A	N	100	300	200	800	1,100	1,500	2,000	2,500	3,100
Percentage supported	A A	Ϋ́	¥ V	35	30	45	45	62	52	49	40	43
Funding from 1 agency	Ϋ́	A A	¥ Y	100	86	72	78	92	63	28	28	63
Funding from 2 agencies	Ϋ́	Ϋ́	A A	0	1	28	22	30	34	38	37	33
Funding from 3+ agencies	N	A	A A	0	0	0	0	2	3	3	2	2
				Enviro	Environmental sciences	secu						
Total number employed	3,400	3,900	4,200	4,200	4,600	4,800	5,200	2,600	5,900	6,000	6,400	6,400
Percentage supported	47	46	43	45	49	54	51	09	63	65	51	54
Funding from 1 agency	63	65	92	73	63	28	62	22	54	48	22	54
Funding from 2 agencies	58	27	24	19	26	30	27	59	32	33	29	35
Funding from 3+ agencies	7	∞	10	တ	7	12	11	16	14	19	16	11
Page 1 of 2												

Appendix table 5-33. **Academic doctoral scientists and engineers reporting federal support from one or more agencies, by field: 1973-95** (Percentages)

	1973	1975	1977	1979	1981	1983	1985ª	1987	1989	1991	1993ª	1995ª
				ח	Life sciences							
Total number employed	34,900	39,400	42,600	47,000	51,300	54,900	58,700	61,300	64,800	006'99	68,200	71,600
Percentage supported	09	29	22	22	29	29	53	65	65	65	52	52
Funding from 1 agency	82	83	84	85	84	82	84	92	9/	74	81	79
Funding from 2 agencies	15	15	14	13	14	16	14	19	18	20	16	17
Funding from 3+ agencies	က	က	ო	7	2	7	7	2	2	9	4	2
					Psychology							
Total number employed	12,200	14,800	16,200	17,700	20,100	21,000	23,100	23,700	25,000	25,200	25,000	26,100
Percentage supported	39	36	33	32	32	30	25	31	35	35	26	27
Funding from 1 agency	82	84	98	86	81	84	84	84	81	80	81	85
Funding from 2 agencies	13	13	12	12	17	15	15	14	15	15	16	13
Funding from 3+ agencies	7	က	0	7	2	7	1	က	4	2	က	8
				So	Social sciences	s						
Total number employed	23,400	28,000	31,100	33,600	36,900	38,900	42,000	42,200	44,500	44,800	44,400	42,500
Percentage supported	26	24	23	20	21	24	17	27	28	28	14	16
Funding from 1 agency	84	98	87	88	86	88	88	79	84	73	9/	81
Funding from 2 agencies	=======================================	12	12	=	14	0	80	16	13	22	21	17
Funding from 3+ agencies	4	3	1	1	0	2	2	4	လ	2	3	2
				_	Engineering							
Total number employed	12,400	13,400	14,800	15,800	16,100	18,100	19,900	21,200	22,900	22,800	23,100	23,800
Percentage supported	22	20	51	49	20	22	42	22	26	63	43	20
Funding from 1 agency	20	71	74	72	75	72	9/	99	63	09	64	19
Funding from 2 agencies	24	22	20	23	19	20	19	24	24	28	28	30
Funding from 3+ agencies	9	7	9	2	9	∞	2	6	13	13	∞	6

Data are not comparable to other years that had reference periods of a total academic year: 1985 data reference support in a single worth; 1993 and 1995 data reference support in a single week. Details may not add to totals because of rounding.

Science & Engineering Indicators – 1998

SOURCE: National Science Foundation, Science Resources Studies Division, unpublished tabulations (1997).

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Appendix table 5-34. Full-time S&E graduate students, by source and mechanism of primary support: 1980-95

Support source	All mechanisms	Fellowships	Traineeships	Research assistantships	Teaching assistantships	Other	Self-support
			Number				
Total							
1980	238,492	20,532	17,550	51,567	53,890	19,446	75,507
1981	242,118	20,106	16,777	52,722	55,746	20,210	76,557
1982	244,830	20,873	14,640	52,580	58,334	20,455	77,948
1983	252,092	21,365	13,514	54,904	60,072	20,960	81,277
1984	253,959	21,638	13,465	57,735	61,257	20,697	79,167
1985	257,351	22,576	13,665	60,995	61,822	20,635	77,658
1986	266,197	22,966	13,526	66,011	62,563	22,246	78,885
1987	271,080	21,965	14,096	70,214	62,859	22,166	79,780
1988	275,204	22,361	14,397	74,588	63,071	21,584	79,203
1989	282,741	23,476	14,527	79,059	64,316	21,082	80,281
1990	292,854	25,269	15,212	80,747	64,973	22,265	84,388
1991	307,049	26,697	15,417	85,175	65,229	22,956	91,575
1992	322,753	28,666	15,376	88,032	65,739	23,565	101,375
1993	329,876	29,170	15,452	90,158	67,344	21,378	106,374
1994	332,453	28,976	15,716	92,033	66,900	21,672	•
	·	•	,	•	•		107,156
1995	330,235	28,954	16,108	89,983	66,147	22,294	106,749
			Federal				
1980	52,969	4,635	13,306	29,316	662	5,050	NA
1981	50,903	4,093	12,176	29,147	619	4,868	NA
1982	47,411	4,097	10,077	28,313	428	4,496	NA
1983	47,764	4,118	9,114	29,152	498	4,882	NA
1984	47,793	4,125	8,970	29,463	400	4,835	NA
1985	49,058	4,423	8,954	30,433	549	4,699	NA
1986	51,365	4,600	8,688	32,739	495	4,843	NA
1987	53,542	4,449	8,922	34,996	444	4,731	NA
1988	55,492	4,569	8,664	36,752	504	5,003	NA
1989	57,444	5,177	8,682	38,555	490	4,540	NA
1990	59,274	6,316	9,242	38,504	609	4,603	NA
1991	63,017	7,447	9,630	40,790	476	4,674	NA
1992	65,634	7,761	10,055	42,588	643	4,587	NA NA
1993	67,697	7,701	10,188	44,504	846	4,644	NA NA
	·			•		-	
1994	68,583	6,945	10,418	45,633	780	4,807	NA
1995	67,469	6,904	10,314	44,503	732	5,016	NA
			Nonfederal				
1980	110,016	15,897	4,244	22,251	53,228	14,396	NA
1981	114,658	16,013	4,601	23,575	55,127	15,342	NA
1982	119,471	16,776	4,563	24,267	57,906	15,959	NA
1983	123,051	17,247	4,400	25,752	59,574	16,078	NA
1984	126,999	17,513	4,495	28,272	60,857	15,862	NA
1985	130,635	18,153	4,711	30,562	61,273	15,936	NA
1986	135,947	18,366	4,838	33,272	62,068	17,403	NA
1987	137,758	17,516	5,174	35,218	62,415	17,435	NA
1988	140,509	17,792	5,733	37,836	62,567	16,581	NA
1989	145,016	18,299	5,845	40,504	63,826	16,542	NA
1990	149,192	18,953	5,970	42,243	64,364	17,662	NA NA
1991	152,457	19,250	5,787	44,385	64,753	18,282	NA NA
	·	•	-				
1992	155,744	20,905	5,321	45,444 45,654	65,096	18,978	NA NA
1993	155,805	21,655	5,264	45,654	66,498	16,734	NA
1994	156,714	22,031	5,298	46,400	66,120	16,865	NA
1995	156,017	22,050	5,794	45,480	65,415	17,278	NA

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Appendix table 5-34. Full-time S&E graduate students, by source and mechanism of primary support: 1980-95

Support source	All mechanisms	Fellowships	Traineeships	Research assistantships	Teaching assistantships	Other	Self-suppor
			Percent				
Total							
1980	100.0	8.6	7.4	21.6	22.6	8.2	31.7
1981	100.0	8.3	6.9	21.8	23.0	8.3	31.6
1982	100.0	8.5	6.0	21.5	23.8	8.4	31.8
1983	100.0	8.5	5.4	21.8	23.8	8.3	32.2
1984	100.0	8.5	5.3	22.7	24.1	8.1	31.2
1985	100.0	8.8	5.3	23.7	24.0	8.0	30.2
1986	100.0	8.6	5.1	24.8	23.5	8.4	29.6
1987	100.0	8.1	5.2	25.9	23.2	8.2	29.4
1988	100.0	8.1	5.2	27.1	22.9	7.8	28.8
1989	100.0	8.3	5.1	28.0	22.7	7.5	28.4
1990	100.0	8.6	5.2	27.6	22.2	7.6	28.8
1991	100.0	8.7	5.0	27.7	21.2	7.5	29.8
1992	100.0	8.9	4.8	27.3	20.4	7.3	31.4
1993	100.0	8.8	4.7	27.3	20.4	6.5	32.2
1994	100.0	8.7	4.7	27.7	20.1	6.5	32.2
1995	100.0	8.8	4.9	27.2	20.0	6.8	32.3
1000	100.0	0.0	Federal	21.2	20.0	0.0	02.0
1980	100.0	8.8	25.1	55.3	1.2	9.5	NA
1981	100.0	8.0	23.9	57.3	1.2	9.6	NA NA
				57.3 59.7			
1982	100.0	8.6	21.3		0.9	9.5	NA
1983	100.0	8.6	19.1	61.0	1.0	10.2	NA
1984	100.0	8.6	18.8	61.6	0.8	10.1	NA
1985	100.0	9.0	18.3	62.0	1.1	9.6	NA
1986	100.0	9.0	16.9	63.7	1.0	9.4	NA
1987	100.0	8.3	16.7	65.4	0.8	8.8	NA
1988	100.0	8.2	15.6	66.2	0.9	9.0	NA
1989	100.0	9.0	15.1	67.1	0.9	7.9	NA
1990	100.0	10.7	15.6	65.0	1.0	7.8	NA
1991	100.0	11.8	15.3	64.7	0.8	7.4	NA
1992	100.0	11.8	15.3	64.9	1.0	7.0	NA
1993	100.0	11.1	15.0	65.7	1.2	6.9	NA
1994	100.0	10.1	15.2	66.5	1.1	7.0	NA
1995	100.0	10.2	15.3	66.0	1.1	7.4	NA
			Nonfederal				
1980	100.0	14.4	3.9	20.2	48.4	13.1	NA
1981	100.0	14.0	4.0	20.6	48.1	13.4	NA
1982	100.0	14.0	3.8	20.3	48.5	13.4	NA
1983	100.0	14.0	3.6	20.9	48.4	13.1	NA
1984	100.0	13.8	3.5	22.3	47.9	12.5	NA
1985	100.0	13.9	3.6	23.4	46.9	12.2	NA
1986	100.0	13.5	3.6	24.5	45.7	12.8	NA
1987	100.0	12.7	3.8	25.6	45.3	12.7	NA
1988	100.0	12.7	4.1	26.9	44.5	11.8	NA
1989	100.0	12.6	4.0	27.9	44.0	11.4	NA
1990	100.0	12.7	4.0	28.3	43.1	11.8	NA
1991	100.0	12.6	3.8	29.1	42.5	12.0	NA
1992	100.0	13.4	3.4	29.2	41.8	12.2	NA
1993	100.0	13.9	3.4	29.3	42.7	10.7	NA NA
1994	100.0	14.1	3.4	29.6	42.2	10.8	NA
1995	100.0	14.1	3.7	29.2	41.9	11.1	NA NA
1000	100.0	14.1	ა.1	29.2	41.8	1 (. 1	INA

NOTE: Science and engineering includes the health fields (medical sciences and other life sciences).

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

See figures 5-17 and 5-18.

Appendix table 5-35. Full-time S&E graduate students, by institution type, and source and mechanism of primary support: 1995

		Source	of support	
Institution type & support mechanism	Total	Federal	Nonfederal	Self
Nu	ımber of full-time S	&E graduate students		
Private, all mechanisms	96,997	19,978	39,557	37,462
Fellowship	13,247	2,849	10,398	NA
Traineeship	7,276	3,870	3,406	NA
Research assistantship	20,070	11,939	8,131	NA
Teaching assistantship	12,293	209	12,084	NA
Other	44,111	1,111	5,538	37,462
Public, all mechanisms	233,238	47,491	116,460	69,287
Fellowship	15,707	4,055	11,652	NA
Traineeship	8,832	6,444	2,388	NA
Research assistantship	69,913	32,564	37,349	NA
Teaching assistantship	53,854	523	53,331	NA
Other	84,932	3,905	11,740	69,287
Pe	ercent of full-time Sa	&E graduate students	·	
Private, all mechanisms	100.0	100.0	100.0	100.0
Fellowship	13.7	14.3	26.3	NA
Traineeship	7.5	19.4	8.6	NA
Research assistantship	20.7	59.8	20.6	NA
Teaching assistantship	12.7	1.0	30.5	NA
Other	45.5	5.6	14.0	100.0
Public, all mechanisms	100.0	100.0	100.0	100.0
Fellowship	6.7	8.5	10.0	NA
Traineeship	3.8	13.6	2.1	NA
Research assistantship	30.0	68.6	32.1	NA
Teaching assistantship	23.1	1.1	45.8	NA
Other	36.4	8.2	10.1	100.0
Pe	ercent of full-time Sa	&E graduate students		
Private, all mechanisms	100.0	20.6	40.8	38.6
Fellowship	100.0	21.5	78.5	NA
Traineeship	100.0	53.2	46.8	NA
Research assistantship	100.0	59.5	40.5	NA
Teaching assistantship	100.0	1.7	98.3	NA
Other	100.0	2.5	12.6	84.9
Public, all mechanisms	100.0	20.4	49.9	29.7
Fellowship	100.0	25.8	74.2	NA
Traineeship	100.0	73.0	27.0	NA
Research assistantship	100.0	46.6	53.4	NA
Teaching assistantship	100.0	1.0	99.0	NA
Other	100.0	4.6	13.8	81.6

NOTE: Science and engineering includes the health sciences (medical sciences and other life sciences).

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

Appendix table 5-36. Primary mechanisms of support for 1995 S&E Ph.D. recipients, by degree field

Field	All mechanisms	Research assistantships	Fellowships	Traineeships	Teaching assistantships	Other	Self-support
			Number				
TOTAL S&E	27,846	8,058	666	3,744	1,795	8,592	4,991
Total sciences	21,839	5,497	525	3,296	1,654	6,603	4,264
Physical sciences	3,840	1,679	91	661	112	1,052	245
Astronomy	173	91	6	20	5	45	6
Chemistry	2,161	826	46	428	72	638	151
Physics	1,479	749	38	212	34	358	88
Other	27	13	1	1	1	11	0
Mathematics	1,190	132	27	566	39	323	103
Computer sciences	998	317	26	152	28	279	196
Environmental sciences	778	314	15	77	24	239	109
Atmospheric sciences	130	72	0	3	2	43	10
Earth sciences	454	170	11	65	13	134	61
Oceanography	114	56	1	4	4	39	10
Other	80	16	3	5	5	23	28
Life sciences	7.737	2.247	213	691	950	2,391	1,245
Agricultural sciences	1,036	407	28	33	23	406	139
Biological sciences	5,370	1.673	171	566	830	1,519	611
Medical sciences	556	104	12	40	52	190	158
Other	775	63	2	52	45	276	337
Psychology	3,419	395	42	368	175	1,072	1,367
Social sciences	3.877	413	111	781	326	1.247	999
Anthropology	410	22	16	68	40	133	131
Economics	1,153	170	34	274	97	394	184
History of science	41	3	3	11	3	11	10
Linguistics	201	11	4	61	17	55	53
Political science	893	71	20	152	75	289	286
Sociology	554	76	17	103	48	167	143
Other	625	60	17	112	46	198	192
Total engineering	6,007	2,561	141	448	141	1,989	727
Aeronautical/	0,007	2,301	141	440	141	1,303	121
astronautical	251	105	5	25	7	90	19
Chemical	708	336	23	44	27	227	51
Civil	656	238	8	34	11	264	101
Electrical/electronics	1,731	703	50	143	36	562	237
Industrial	283	64	6	40	11	93	69
Mechanical	1,024	452	11	103	15	325	118
Materials	588	341	11	19	9	167	41
Other	766	322	27	40	25	261	91
<u> </u>	100	022	۷1	40	20	201	<i>3</i> I

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Appendix table 5-36. Primary mechanisms of support for 1995 S&E Ph.D. recipients, by degree field

Field	All mechanisms	Research assistantships	Fellowships	Traineeships	Teaching assistantships	Other	Self-suppor
			Percent				
TOTAL S&E	100.0	28.9	2.4	13.4	6.4	30.9	17.9
Total sciences	100.0	25.2	2.4	15.1	7.6	30.2	19.5
Physical sciences	100.0	43.7	2.4	17.2	2.9	27.4	6.4
Astronomy	100.0	52.6	3.5	11.6	2.9	26.0	3.5
Chemistry	100.0	38.2	2.1	19.8	3.3	29.5	7.0
Physics	100.0	50.6	2.6	14.3	2.3	24.2	5.9
Other	100.0	48.1	3.7	3.7	3.7	40.7	0.0
Mathematics	100.0	11.1	2.3	47.6	3.3	27.1	8.7
Computer sciences	100.0	31.8	2.6	15.2	2.8	28.0	19.6
Environmental sciences	100.0	40.4	1.9	9.9	3.1	30.7	14.0
Atmospheric sciences	100.0	55.4	0.0	2.3	1.5	33.1	7.7
Earth sciences	100.0	37.4	2.4	14.3	2.9	29.5	13.4
Oceanography	100.0	49.1	0.9	3.5	3.5	34.2	8.8
Other	100.0	20.0	3.8	6.3	6.3	28.8	35.0
Life sciences	100.0	29.0	2.8	8.9	12.3	30.9	16.1
Agricultural sciences	100.0	39.3	2.7	3.2	2.2	39.2	13.4
Biological sciences	100.0	31.2	3.2	10.5	15.5	28.3	11.4
Medical sciences	100.0	18.7	2.2	7.2	9.4	34.2	28.4
Other	100.0	8.1	0.3	6.7	5.8	35.6	43.5
Psychology	100.0	11.6	1.2	10.8	5.1	31.4	40.0
Social sciences	100.0	10.7	2.9	20.1	8.4	32.2	25.8
Anthropology	100.0	5.4	3.9	16.6	9.8	32.4	32.0
Economics	100.0	14.7	2.9	23.8	8.4	34.2	16.0
History of science	100.0	7.3	7.3	26.8	7.3	26.8	24.4
Linguistics	100.0	5.5	2.0	30.3	8.5	27.4	26.4
Political science	100.0	8.0	2.2	17.0	8.4	32.4	32.0
Sociology	100.0	13.7	3.1	18.6	8.7	30.1	25.8
Other	100.0	9.6	2.7	17.9	7.4	31.7	30.7
Total engineering	100.0	42.6	2.3	7.5	2.3	33.1	12.1
Aeronautical/	100.0	12.0	2.0	7.0	2.0	00.1	
astronautical	100.0	41.8	2.0	10.0	2.8	35.9	7.6
Chemical	100.0	47.5	3.2	6.2	3.8	32.1	7.2
Civil	100.0	36.3	1.2	5.2	1.7	40.2	15.4
Electrical/electronics	100.0	40.6	2.9	8.3	2.1	32.5	13.7
Industrial	100.0	22.6	2.1	14.1	3.9	32.9	24.4
Mechanical	100.0	44.1	1.1	10.1	1.5	31.7	11.5
Materials	100.0	58.0	1.9	3.2	1.5	28.4	7.0
Other	100.0	42.0	3.5	5.2	3.3	34.1	7.0 11.9

 $SOURCE: National \ Science \ Foundation, \ Science \ Resources \ Studies \ Division, \ Survey \ of \ Earned \ Doctorates, \ various \ years, \ unpublished \ tabulations.$

See figure 5-20.

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Appendix table 5-37. Full-time S&E graduate students, by field and mechanism of primary support: 1995

Field	All mechanisms	Research assistantships	Fellowships	Traineeships	Teaching assistantships	Other	Self-support
			Number				
TOTAL S&E	330,235	89,983	28,954	16,108	66,147	22,294	106,749
Total sciences	262,373	62,958	22,921	15,099	55,931	17,289	88,175
Physical sciences	28,892	11,808	2,354	688	11,710	730	1,602
Astronomy	871	439	148	28	225	5	26
Chemistry	16,750	6,466	1,270	445	7,386	372	811
Physics	11,054	4,842	929	215	4,073	349	646
Other	217	61	7	0	26	4	119
Mathematics	13,422	1,451	1,274	222	7,316	675	2,484
Computer sciences	16,564	3,921	924	216	3,364	1,551	6,588
Environmental sciences	11,290	4,661	891	136	2,507	730	2,365
Atmospheric sciences	959	619	67	8	107	69	89
Earth sciences	5,810	2,151	512	59	1,855	334	899
Oceanography	2,228	1,257	195	24	215	166	371
Other	2.293	634	117	45	330	161	1.006
Life sciences	100.132	29.158	8.104	10.942	13.089	6.587	32,252
Agricultural sciences	9,630	5,401	454	146	941	477	2,211
Biological sciences	48,283	19,182	5,395	5,308	9,293	2,143	6,962
Medical sciences	13.863	2.928	1.272	1.661	1.246	1.292	5.464
Other	28,356	1,647	983	3,827	1,609	2,675	17,615
Psychology	35,762	4,626	1,824	1,115	6,152	3,094	18,951
Social sciences	56,311	7.333	7.550	1.780	11.793	3.922	23.933
Anthropology	5,792	452	1,168	132	1,278	344	2,418
Economics	11,746	2,094	1,546	271	3,028	809	3,998
History of science	340	17	127	10	99	18	69
Linguistics	2.486	177	369	50	701	282	907
Political science	17,660	1,624	2,468	777	2,666	1,136	8,989
Sociology	7,353	1,131	915	241	2,145	431	2,490
Other	10.934	1.838	957	299	1,876	902	5.062
Total engineering	67,862	27,025	6,033	1,009	10,216	5,005	18,574
Aeronautical/	07,002	21,023	0,033	1,009	10,210	3,003	10,374
astronautical	2.693	1.175	262	31	315	377	533
Chemical	5.962	3.100	791	105	907	218	841
Civil	12,248	4.225	924	196	1,850	816	4,237
Electrical/electronics	18,303	6,684	1.455	156	3,137	1.439	5,432
Industrial	5.328	1.339	300	37	824	504	2.324
Mechanical	11,119	4,419	942	187	1,950	777	2,844
Materials	3,880	2,535	371	48	352	123	451
Other	8.329	3.548	988	249	881	751	1.912
	0,020	0,040	300	243	JU 1	751	1,312

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Appendix table 5-37. Full-time S&E graduate students, by field and mechanism of primary support: 1995

Field	All mechanisms	Research assistantships	Fellowships	Traineeships	Teaching assistantships	Other	Self-support
			Percent				
TOTAL S&E	100.0	27.2	8.8	4.9	20.0	6.8	32.3
Total sciences	100.0	24.0	8.7	5.8	21.3	6.6	33.6
Physical sciences	100.0	40.9	8.1	2.4	40.5	2.5	5.5
Astronomy	100.0	50.4	17.0	3.2	25.8	0.6	3.0
Chemistry	100.0	38.6	7.6	2.7	44.1	2.2	4.8
Physics	100.0	43.8	8.4	1.9	36.8	3.2	5.8
Other	100.0	28.1	3.2	0.0	12.0	1.8	54.8
Mathematics	100.0	10.8	9.5	1.7	54.5	5.0	18.5
Computer sciences	100.0	23.7	5.6	1.3	20.3	9.4	39.8
Environmental sciences	100.0	41.3	7.9	1.2	22.2	6.5	20.9
Atmospheric sciences	100.0	64.5	7.0	0.8	11.2	7.2	9.3
Earth sciences	100.0	37.0	8.8	1.0	31.9	5.7	15.5
Oceanography	100.0	56.4	8.8	1.1	9.6	7.5	16.7
Other	100.0	27.6	5.1	2.0	14.4	7.0	43.9
Life sciences	100.0	29.1	8.1	10.9	13.1	6.6	32.2
Agricultural sciences	100.0	56.1	4.7	1.5	9.8	5.0	23.0
Biological sciences	100.0	39.7	11.2	11.0	19.2	4.4	14.4
Medical sciences	100.0	21.1	9.2	12.0	9.0	9.3	39.4
Other	100.0	5.8	3.5	13.5	5.7	9.4	62.1
Psychology	100.0	12.9	5.1	3.1	17.2	8.7	53.0
Social sciences	100.0	13.0	13.4	3.2	20.9	7.0	42.5
Anthropology	100.0	7.8	20.2	2.3	22.1	5.9	41.7
Economics	100.0	17.8	13.2	2.3	25.8	6.9	34.0
History of science	100.0	5.0	37.4	2.9	29.1	5.3	20.3
Linguistics	100.0	7.1	14.8	2.0	28.2	11.3	36.5
Political science	100.0	9.2	14.0	4.4	15.1	6.4	50.9
Sociology	100.0	15.4	12.4	3.3	29.2	5.9	33.9
Other	100.0	16.8	8.8	2.7	17.2	8.2	46.3
Total engineering	100.0	39.8	8.9	1.5	15.1	7.4	27.4
Aeronautical/							
astronautical	100.0	43.6	9.7	1.2	11.7	14.0	19.8
Chemical	100.0	52.0	13.3	1.8	15.2	3.7	14.1
Civil	100.0	34.5	7.5	1.6	15.1	6.7	34.6
Electrical/electronics	100.0	36.5	7.9	0.9	17.1	7.9	29.7
Industrial	100.0	25.1	5.6	0.7	15.5	9.5	43.6
Mechanical	100.0	39.7	8.5	1.7	17.5	7.0	25.6
Materials	100.0	65.3	9.6	1.2	9.1	3.2	11.6
Other	100.0	42.6	11.9	3.0	10.6	9.0	23.0

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

See figure 5-20.

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Appendix table 5-38. Full-time S&E graduate students with a research assistantship as mechanism of primary support, by field: 1995

Field	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
		Nun	Number of full-time S&E	ime S&E gra	graduate students	ints					
TOTAL S&E	966,09	66,011	70,214	74,588	79,059	80,747	85,175	88,032	90,158	92,033	89,983
Total sciences	43,085	45,593	48,044	51,139	54,466	55,448	58,399	60,492	62,227	63,951	62,958
Physical sciences	10,284	10,992	11,556	12,056	12,442	12,138	12,229	12,445	12,293	12,378	11,808
Astronomy	305	323	336	338	372	383	397	425	395	467	439
Chemistry	5,797	6,173	6,444	6,644	6,803	6,572	6,569	909'9	6,586	069'9	6,466
Physics	4,133	4,447	4,719	5,026	5,235	5,153	5,232	5,359	5,251	5,131	4,842
Other	49	49	25	48	32	30	31	22	61	06	19
Mathematics	866	1,038	1,111	1,226	1,304	1,335	1,356	1,410	1,436	1,534	1,451
Computer sciences	2,058	2,322	2,817	3,032	3,324	3,334	3,565	3,682	3,802	3,903	3,921
Environmental sciences	3,707	3,827	3,647	3,879	4,150	4,189	4,387	4,615	4,729	4,857	4,661
Atmospheric sciences	447	418	441	479	499	493	529	909	626	629	619
Earth sciences	2,126	2,105	1,890	1,973	2,071	2,054	2,061	2,091	2,172	2,215	2,151
Oceanography	848	962	896	1,051	1,166	1,170	1,273	1,339	1,331	1,401	1,257
Other	286	342	353	376	414	472	524	629	009	582	634
Life sciences	17,888	19,220	20,191	21,570	23,162	23,923	25,809	26,755	28,046	29,202	29,158
Agricultural sciences	4,445	4,703	4,603	4,552	4,730	4,755	5,002	5,174	5,239	5,385	5,401
Biological sciences	11,222	12,086	12,944	14,125	15,189	15,764	16,846	17,627	18,853	19,438	19,182
Medical sciences	1,326	1,465	1,675	1,843	2,020	2,188	2,584	2,630	2,582	2,881	2,928
Other	895	996	696	1,050	1,223	1,216	1,377	1,324	1,372	1,498	1,647
Psychology	3,070	3,101	3,227	3,715	3,846	4,052	4,235	4,306	4,559	4,676	4,626
Social sciences	5,080	5,093	5,495	5,661	6,238	6,477	6,818	7,279	7,362	7,401	7,333
Anthropology	277	287	346	353	407	449	462	454	452	454	452
Economics	1,955	2,003	1,994	2,064	2,004	2,055	2,150	2,165	2,214	2,173	2,094
History of science	=======================================	19	18	23	14	14	34	24	7	22	17
Linguistics	163	126	190	179	202	218	178	169	196	197	177
Political science	1,028	1,015	1,116	1,197	1,378	1,375	1,527	1,757	1,637	1,671	1,624
Sociology	292	191	998	860	922	1,117	1,073	1,109	1,202	1,160	1,131
Other	881	876	965	982	1,278	1,249	1,394	1,601	1,654	1,724	1,838
Total engineering	17,910	20,418	22,170	23,449	24,593	25,299	26,776	27,540	27,931	28,082	27,025
Aeronautical/astronautical	725	823	815	934	1,040	1,137	1,232	1,222	1,266	1,245	1,175
Chemical	2,454	2,582	2,745	2,814	2,813	2,839	2,987	3,012	3,120	3,270	3,100
Civil	2,417	2,786	2,900	3,072	3,042	3,115	3,565	3,936	4,048	4,254	4,225
Electrical/electronic	3,695	4,474	5,132	5,735	6,141	6,224	6,556	6,867	6,925	6,855	6,684
Industrial	572	202	923	1,030	1,141	1,130	1,249	1,235	1,271	1,342	1,339
Mechanical	3,280	3,666	3,947	4,069	4,248	4,306	4,630	4,731	4,787	4,688	4,419
Materials	1,963	2,247	2,264	2,333	2,512	2,547	2,507	2,661	2,651	2,608	2,535
Other	2,804	3,135	3,444	3,462	3,656	4,001	4,050	3,876	3,863	3,820	3,548

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1995

1994

1993

1992

1991

1990

1989

1988

1987

1986

1985

Field

Science & Engineering Indicators – 1998

Appendix table 5-38. Full-time S&E graduate students with a research assistantship as mechanism of primary support, by field: 1995

	200	200			0	- 22					0
		Perc	Percent of full-time S&E		graduate students	nts					
TOTAL S&E	23.7	24.8	25.9	27.1	28.0	27.6	27.7	27.3	27.3	27.7	27.2
Total sciences	21.4	22.1	23.0	24.1	24.9	24.4	24.7	24.4	24.3	24.5	24.0
Physical sciences	38.6	39.6	40.7	42.2	42.6	41.2	40.6	40.6	40.2	41.2	40.9
Astronomy	48.0	49.4	49.5	47.9	48.8	48.5	49.0	9.09	46.6	49.0	50.4
Chemistry	37.2	38.6	39.7	41.3	41.8	40.1	39.3	38.9	38.3	39.1	38.6
Physics	40.2	40.6	41.7	43.2	43.5	42.3	42.1	42.2	42.4	43.6	43.8
Other	30.2	32.0	29.4	33.6	25.2	24.6	23.1	37.9	37.7	40.9	28.1
Mathematics	8.4	8.4	8.5	9.1	9.5	9.6	9.5	9.6	6.6	10.8	10.8
Computer sciences	14.8	15.5	18.4	20.0	21.3	20.0	21.6	21.0	21.9	23.4	23.7
Environmental sciences	32.7	34.0	34.9	38.1	41.4	40.9	42.3	42.0	41.6	42.3	41.3
Atmospheric sciences	51.3	48.9	53.5	57.8	61.6	59.5	61.6	63.2	63.9	66.4	64.5
Earth sciences	27.6	28.5	28.4	31.3	34.6	35.4	36.2	35.5	36.4	37.3	37.0
Oceanography	54.3	56.8	58.3	64.5	64.8	60.5	63.9	62.8	61.1	60.1	56.4
Other	23.9	26.0	27.3	26.4	29.0	28.0	28.6	28.8	26.8	26.5	27.6
Life sciences	25.7	27.3	28.4	29.6	30.8	30.9	31.5	31.1	30.6	30.2	29.1
Agricultural sciences	48.1	50.3	9.05	49.9	52.1	52.3	53.8	54.7	55.3	26.7	56.1
Biological sciences	30.3	32.0	33.9	36.0	37.6	38.5	39.5	39.7	40.6	40.5	39.7
Medical sciences	15.5	16.8	18.4	19.2	20.2	20.7	23.5	22.4	20.4	21.9	21.1
Other	6.1	9.9	9.9	7.0	7.7	7.2	7.3	6.5	0.9	5.8	2.8
Psychology	12.1	11.8	11.8	13.2	13.1	13.2	13.1	12.6	13.1	13.2	12.9
Social sciences	11.8	11.9	12.6	12.9	13.8	13.4	13.5	13.4	13.2	13.1	13.0
Anthropology	7.1	7.1	8.4	8.3	9.5	9.3	9.1	8.5	8.3	7.8	7.8
Economics	17.9	18.3	18.4	18.9	18.2	18.3	18.1	17.6	18.3	18.2	17.8
History of science	4.8	8.0	6.7	8.6	5.1	4.5	11.2	7.3	2.1	6.5	2.0
Linguistics	7.0	5.3	7.8	7.1	8.2	8.4	7.0	8.9	7.7	7.8	7.1
Political science	7.9	9.7	9.8	9.1	8.6	9.0	9.5	6.6	8.9	9.3	9.5
Sociology	14.7	14.8	15.5	15.2	16.2	17.3	16.3	15.6	16.5	15.6	15.4
Other	12.2	13.0	13.2	14.2	17.7	16.1	17.0	17.7	17.2	16.6	16.8
Total engineering	32.0	33.9	35.8	37.2	38.2	38.3	37.7	37.0	37.8	39.2	39.8
Aeronautical/astronautical	36.4	38.2	34.4	36.9	37.5	37.8	37.1	37.0	38.8	41.5	43.6
Chemical	44.2	46.2	48.4	52.5	53.3	52.2	51.6	20.2	51.6	53.6	52.0
Civil	24.8	27.9	30.1	30.9	30.5	30.8	31.5	31.6	32.5	33.7	34.5
Electrical/electronic	25.0	27.5	30.0	32.4	33.3	33.3	32.9	32.7	33.9	35.3	36.5
Industrial	16.6	18.5	22.2	24.0	24.5	23.7	22.3	20.3	21.5	22.7	25.1
Mechanical	37.0	37.5	38.6	39.1	40.5	39.6	39.6	38.2	38.6	39.5	39.7
Materials	63.5	2.99	62.9	67.3	67.5	64.8	61.8	62.3	62.4	63.5	65.3
Other	33.4	34.1	36.9	37.3	40.5	43.7	43.3	43.1	42.4	44.9	42.6
	:									:	

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

See figure 5-19.

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Appendix table 5-39. **S&E** research assistants, by field and primary source of support: 1995

				mber of h assistants		cent of assistants
Field	Total number	Total percent	Federal	Nonfederal	Federal	Nonfederal
TOTAL SCIENCE & ENGINEERING	89,983	100.0	44,503	45,480	49.5	50.5
Total sciences	62,958	70.0	31,868	31,090	50.6	49.4
Physical sciences	11,808	13.1	8,852	2,956	75.0	25.0
Astronomy	439	0.5	335	104	76.3	23.7
Chemistry	6,466	7.2	4,721	1,745	73.0	27.0
Physics	4,842	5.4	3,764	1,078	77.7	22.3
Other	61	0.1	32	29	52.5	47.5
Mathematics	1,451	1.6	659	792	45.4	54.6
Computer sciences	3,921	4.4	2,429	1,492	61.9	38.1
Environmental sciences	4,661	5.2	2,935	1,726	63.0	37.0
Atmospheric sciences	619	0.7	507	112	81.9	18.1
Earth sciences	2,151	2.4	1,339	812	62.3	37.7
Oceanography	1,257	1.4	848	409	67.5	32.5
Other	634	0.7	241	393	38.0	62.0
Life sciences	29,158	32.4	14,036	15,122	48.1	51.9
Agricultural sciences	5,401	6.0	1,863	3,538	34.5	65.5
Biological sciences	19,182	21.3	10,513	8,669	54.8	45.2
Medical sciences	2.928	3.3	1.165	1.763	39.8	60.2
Other	1,647	1.8	495	1,152	30.1	69.9
Psychology	4,626	5.1	1,481	3,145	32.0	68.0
Social sciences	7,333	8.1	1,476	5,857	20.1	79.9
Anthropology	452	0.5	102	350	22.6	77.4
Economics	2,094	2.3	533	1,561	25.5	74.5
History of science	17	0.0	1	16	5.9	94.1
Linguistics	177	0.2	58	119	32.8	67.2
Political science	1.624	1.8	115	1,509	7.1	92.9
Sociology	1.131	1.3	237	894	21.0	79.0
Other	1,838	2.0	430	1.408	23.4	76.6
Total engineering	27,025	30.0	12.635	14,390	46.8	53.2
Aeronautical/astronautical	1,175	1.3	668	507	56.9	43.1
Chemical	3,100	3.4	1,400	1,700	45.2	54.8
Civil	4,225	4.7	1,581	2,644	37.4	62.6
Electrical/electronics	6,684	7.4	3,316	3,368	49.6	50.4
Industrial	1,339	1.5	408	931	30.5	69.5
Mechanical	4,419	4.9	2,201	2,218	49.8	50.2
Materials	2,535	2.8	1,374	1,161	54.2	45.8
Other	3,548	3.9	1,687	1,861	47.5	52.5

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

Appendix table 5-40. S&E research assistants whose primary source of support is the Federal Government, by field: 1975-95 (Percentages)

Field	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TOTAL S&E	9.75	57.2	57.4	Α	57.2	56.9			53.1	51.0	49.9	49.6	49.8	49.3	48.8	47.7	47.9	48.4	49.4	49.6	49.5
Total sciences	55.5	54.8	55.2	Ϋ́	55.3				51.2	50.2	51.1	50.8	51.2	50.5	50.2	49.3	49.5	50.1	51.1	51.0	9.09
Physical sciences	85.2	83.8	84.7	₹	83.4	83.7			81.7	81.1	78.4	78.8	76.8	74.4	73.6	72.9	72.8	73.0	74.7	76.1	75.0
Astronomy	84.5	87.7	84.0	₹	82.0				86.7	82.1	86.2	88.9	75.3	79.0	77.4	70.2	72.5	79.1	83.5	80.5	29.3
Chemistry	82.4	80.3	80.2	₹	79.9				77.4	77.3	75.3	76.2	73.4	71.8	8.69	9.02	69.1	8.69	71.6	73.8	73.0
Physics	89.0	87.9	90.5	₹	88.1				87.9	86.5	82.7	82.2	81.7	77.8	78.5	76.1	77.5	76.4	78.1	78.8	7.77
Other	25.8	30.0	73.7	₹	56.3	100.0			39.5	52.8	36.7	42.9	52.6	41.7	50.0	50.0	48.4	72.7	70.5	74.4	52.5
Mathematics	47.7	51.3	51.4	₹	51.4		•		43.6	47.1	47.9	51.8	57.2	54.3	50.8	45.7	47.5	48.5	51.3	48.4	45.4
Computer sci	9.09	52.8	65.5	₹	71.1		65.1		60.2	60.1	52.0	49.3	53.2	54.2	53.5	53.5	54.8	54.2	58.5	61.0	61.9
Environmental sci	73.7	71.5	71.6	Ž	75.6		_		66.4	65.2	64.8	61.9	61.5	9.69	29.7	29.0	58.4	62.5	63.4	63.3	63.0
Atmospheric sci	79.7	2.06	93.7	₹	95.3	91.0			83.4	81.4	87.7	9.98	86.8	78.9	89.0	93.5	86.0	9.68	87.4	86.8	81.9
Earth sciences	74.3	69.1	71.2	₹	74.0		_		63.7	62.4	60.3	58.4	58.5	57.5	59.4	57.8	57.4	9.09	61.6	6.09	62.3
Oceanography	73.3	69.7	68.3	¥	74.8		_		70.4	70.5	71.7	9.99	62.9	60.5	55.1	57.4	56.9	62.7	65.0	65.0	67.5
Other	6.09	61.6	52.4	₹	60.7		_		49.5	46.0	42.0	39.8	33.7	43.9	39.4	32.2	38.0	40.6	41.0	41.9	38.0
Life sciences	47.5	48.0	47.2	₹	46.9		·		44.1	42.1	44.7	44.6	46.4	46.7	47.3	46.8	47.2	47.9	48.5	48.3	48.1
Agricultural sci	35.7	34.1	34.8	₹	32.9				28.9	25.1	29.6	29.5	31.3	32.3	32.8	32.2	33.3	34.2	33.4	32.3	34.5
Biological sci	52.8	54.6	53.0	₹	54.2				52.2	50.9	52.3	52.2	53.1	53.1	54.1	53.5	53.8	54.1	55.0	54.7	54.8
Medical sci	0.09	57.4	53.9	₹	47.8		·		42.5	37.2	40.1	38.6	43.5	42.1	41.6	38.8	38.8	41.4	42.4	43.2	39.8
Other	53.4	45.3	49.0	₹	35.6				27.8	28.7	30.9	31.5	33.8	31.6	28.0	32.2	31.6	31.9	27.6	32.2	30.1
Psychology	45.5	43.2	44.9	₹	46.3				31.9	31.8	33.1	32.9	33.4	32.5	33.1	32.7	33.9	33.4	34.0	31.7	32.0
Social sciences	29.1	27.6	28.5	¥	26.9				18.5	17.7	19.1	17.4	16.7	16.6	16.6	17.0	18.1	19.1	20.2	19.4	20.1
Anthropology	41.3	34.8	29.1	₹	34.8		Ť		24.8	15.8	22.4	16.7	19.7	19.5	15.7	12.2	13.4	20.7	23.0	19.6	22.6
Economics	29.5	25.7	30.5	Ž	28.7				22.7	21.5	23.7	22.6	22.5	21.7	23.1	21.6	21.0	22.1	24.4	24.9	25.5
History of sci	0.0	30.0	41.7	₹	18.2				0.0	0.0	9.1	0.0	9.9	13.0	7.1	21.4	20.6	12.5	42.9	18.2	5.9
Linguistics	38.8	56.3	43.3	Ž	31.7				27.7	24.4	22.7	31.7	16.8	10.1	19.3	14.7	23.6	28.4	28.6	32.5	32.8
Political science	10.3	11.8	12.5	¥	11.2				4.9	9.9	6.1	4.4	3.1	5.4	0.9	8.9	8.6	9.9	8.7	8.9	7.1
Sociology	35.1	34.3	35.0	₹	35.7	39.4	36.9	25.8	23.5	21.7	28.4	23.5	19.2	19.7	18.3	19.4	21.3	22.5	21.5	19.1	21.0
Other	33.1	32.3	27.6	Ž	26.9				18.4	20.7	14.3	13.6	17.2	17.4	16.4	20.4	20.9	26.3	23.2	23.4	23.4
Total engineering	63.1	63.7	63.4	Ϋ́	62.4				57.9	53.2	47.1	46.8	46.8	46.6	45.6	44.2	44.4	44.7	45.6	46.2	46.8
Aero./astronautical	75.2	68.2	73.6	₹	70.6		_		78.3	77.9	62.9	8.79	9.69	6.79	59.9	57.3	60.1	58.0	57.4	8.73	56.9
Chemical	61.9	61.2	61.6	¥	55.9				52.0	49.2	44.9	47.3	48.2	46.0	44.5	44.9	43.1	43.3	44.6	43.0	45.2
Civil	52.5	54.8	52.4	Ž	56.8				47.1	45.5	41.7	40.1	42.1	39.7	39.4	37.9	39.5	40.0	39.0	39.0	37.4
Electrical/electronic	77.7	77.3	75.1	¥	72.3				66.4	57.6	46.0	45.4	45.6	47.3	44.0	42.9	43.7	43.8	44.3	46.7	49.6
Industrial	42.6	36.1	46.1	Ž	40.9		·		39.5	30.3	26.9	24.8	26.8	28.1	25.2	23.8	29.9	27.4	28.2	31.1	30.5
Mechanical	63.9	9.99	67.5	¥	64.7		_		0.09	55.2	48.3	46.6	48.8	50.7	50.3	47.7	45.8	46.6	50.3	51.3	49.8
Materials	71.0	74.5	72.7	₹	76.7		-		67.8	63.5	58.4	58.9	54.8	55.2	56.2	52.1	9.09	52.8	52.5	52.6	54.2
Other	54.7	56.1	54.6	Ϋ́	53.8				51.5	48.5	44.9	45.4	44.0	41.4	43.8	43.5	45.0	45.2	46.6	47.4	47.5

NOTE: Science and engineering includes the health sciences (medical sciences and other life sciences).

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

See figure 5-21.

Appendix table 5-41. Federal research assistantships, by agency of primary support: 1972-95

	All federal agencies	National Institutes of Health	Other Department of Health & Human Services	National Science Foundation	Department of Defense	Department of Agriculture ^a	All other agencies
			Number				
1972	20,666	3,395	513	6,832	2,676	NA	7,250
1973	20,584	2,953	793	6,901	2,371	NA	7,566
1974	22,255	3,468	906	6,899	2,657	NA	8,325
1975	23,037	3,884	866	6,819	2,494	NA	8,974
1976	24,338	4,450	882	7,031	2,537	NA	9,438
1977	25,066	4,304	931	7,037	2,637	NA	10,157
1978	NA	NA	NA	NA	NA	NA	NA
1979	28,008	5,060	1,100	7,501	2,801	NA	11,546
1980	29,316	5,436	587	7,627	2,934	NA	12,732
1981	29,147	5,505	543	7,596	3,297	NA	12,206
1982	28,313	5,295	509	7,747	3,467	NA	11,295
1983	29,152	5,456	549	8,066	3,934	NA	11,147
1984	29,463	5,762	583	8,283	4,081	NA	10,754
1985	30,433	6,147	751	8,558	4,195	1,818	8,964
	32,739	7,001	710	9,084	4,646	1,954	9,344
1986 1987	34,996	7,662	814	•	,	2,325	9,091
		•		9,487	5,617		
1988	36,752	8,598	761	9,822	6,028	2,300	9,243
1989	38,555	9,342	906	9,875	5,916	2,448	10,068
1990	38,504	9,463	965	9,705	5,412	2,431	10,528
1991	40,790	9,990	1,055	10,161	5,484	2,816	11,284
1992	42,588	10,623	986	10,652	5,727	2,959	11,641
1993	44,504	11,368	725	10,814	6,232	3,019	12,346
1994	45,633	11,624	902	11,194	6,217	3,143	12,553
1995	44,503	11,382	990 Darsont	10,672	6,337	2,997	12,125
4070	100.0	40.4	Percent		10.0		05.4
1972	100.0	16.4	2.5	33.1	12.9	NA	35.1
1973	100.0	14.3	3.9	33.5	11.5	NA	36.8
1974	100.0	15.6	4.1	31.0	11.9	NA	37.4
1975	100.0	16.9	3.8	29.6	10.8	NA	39.0
1976	100.0	18.3	3.6	28.9	10.4	NA	38.8
1977	100.0	17.2	3.7	28.1	10.5	NA	40.5
1978	NA	NA	NA	NA	NA	NA	NA
1979	100.0	18.1	3.9	26.8	10.0	NA	41.2
1980	100.0	18.5	2.0	26.0	10.0	NA	43.4
1981	100.0	18.9	1.9	26.1	11.3	NA	41.9
1982	100.0	18.7	1.8	27.4	12.2	NA	39.9
1983	100.0	18.7	1.9	27.7	13.5	NA	38.2
1984	100.0	19.6	2.0	28.1	13.9	NA	36.5
1985	100.0	20.2	2.5	28.1	13.8	6.0	29.5
1986	100.0	21.4	2.2	27.7	14.2	6.0	28.5
1988	100.0	23.4	2.1	26.7	16.4	6.3	25.1
1989	100.0	24.2	2.3	25.6	15.3	6.3	26.1
1990	100.0	24.6	2.5	25.2	14.1	6.3	27.3
	100.0	24.5	2.6	24.9	13.4	6.9	27.7
1991			2.3	25.0	13.4	6.9	27.3
	100.0	24.9	۷.۵				
1992	100.0 100.0	24.9 25.5					
1991 1992 1993 1994	100.0 100.0 100.0	24.9 25.5 25.5	1.6 2.0	24.3 24.5	14.0 13.6	6.8 6.9	27.7 27.5

NOTE: Percentages may not total 100 because of rounding.

^aData were reported for the Department of Agriculture for the first time in 1985.

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

Appendix table 5-42. **S&E research assistants with primary support from federal agencies, by field: 1995** (Percentages)

Field	All federal agencies	National Science Foundation	Department of Defense	National Institutes of Health	Other Department of Health & Human Services	Department of Agriculture	All other agencies
TOTAL S&E	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total sciences	71.6	65.6	44.8	95.3	88.9	89.8	62.7
Physical sciences	19.9	30.2	15.6	14.3	13.7	1.2	23.4
Astronomy	0.8	1.2	0.1	0.0	0.0	0.0	1.7
Chemistry	10.6	15.8	6.9	13.6	12.5	1.0	7.4
Physics	8.5	13.3	8.6	0.6	1.2	0.2	14.1
Other	0.1	0.0	0.0	0.1	0.0	0.0	0.1
Mathematics	1.5	2.7	2.0	0.4	1.8	0.4	1.4
Computer sciences	5.5	8.4	16.3	0.7	1.1	0.4	3.3
Environmental sciences	6.6	11.6	4.3	0.2	0.3	1.9	11.1
Atmospheric sciences	1.1	1.8	0.7	0.0	0.2	0.3	2.1
Earth sciences	3.0	6.7	0.4	0.0	0.0	0.5	4.7
Oceanography	1.9	2.7	2.7	0.1	0.0	0.1	3.1
Other	0.5	0.3	0.4	0.1	0.1	1.0	1.1
Life sciences	31.5	9.2	3.9	71.6	52.8	72.2	16.3
Agricultural sciences	4.2	0.7	0.4	0.1	0.5	37.6	5.1
Biological sciences	23.6	7.9	2.8	62.2	32.9	32.9	9.1
Medical sciences	2.6	0.4	0.6	7.1	8.8	1.6	1.2
Other	1.1	0.2	0.1	2.2	10.6	0.0	0.9
Psychology	3.3	1.2	1.8	7.0	14.4	0.5	2.4
Social sciences	3.3	2.2	0.9	1.2	4.6	13.1	4.9
Anthropology	0.2	0.2	0.1	0.1	0.0	0.0	0.5
Economics	1.2	0.4	0.1	0.1	1.4	10.3	1.3
History of science	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Linguistics	0.1	0.2	0.1	0.1	0.2	0.0	0.1
Political science	0.3	0.2	0.1	0.0	0.7	0.3	0.6
Sociology	0.5	0.4	0.0	0.7	1.8	1.5	0.5
Other	1.0	0.9	0.6	0.2	0.5	1.0	1.9
Total engineering	28.4	34.4	55.2	4.7	11.1	10.2	37.3
Aeronautical/astronautical	1.5	0.7	4.0	0.0	0.2	0.1	2.7
Chemical	3.1	5.5	2.3	0.6	1.5	1.9	4.2
Civil	3.6	4.2	3.5	0.3	1.0	1.6	6.8
Electrical/electronics	7.5	10.4	21.7	0.7	1.7	1.1	5.8
Industrial	0.9	1.2	1.2	0.1	2.2	0.0	1.4
Mechanical	4.9	5.1	10.1	0.6	0.7	0.1	7.8
Materials	3.1	4.0	6.8	0.1	1.1	0.1	4.1
Other	3.8	3.2	5.7	2.4	2.6	5.2	4.4

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

See figure 5-22.

Appendix table 5-43. **S&E** research assistants with primary support from the Federal Government, by field and agency of primary support: 1995 (Percentages)

Field	All federal agencies	National Science Foundation	Department of Defense	National Institutes of Health	Other Department of Health & Human Services	Department of Agriculture	All other agencies
TOTAL S&E	100.0	24.0	14.2	25.6	2.2	6.7	27.2
Total sciences	100.0	22.0	8.9	34.0	2.8	8.4	23.9
Physical sciences	100.0	36.5	11.2	18.4	1.5	0.4	32.0
Astronomy	100.0	37.3	2.4	0.0	0.0	0.0	60.3
Chemistry	100.0	35.6	9.3	32.7	2.6	0.6	19.1
Physics	100.0	37.7	14.5	1.9	0.3	0.2	45.5
Other	100.0	0.0	0.0	43.8	0.0	0.0	56.3
Mathematics	100.0	43.6	19.0	7.0	2.7	2.0	25.8
Computer sciences	100.0	37.1	42.5	3.1	0.5	0.5	16.4
Environmental sciences	100.0	42.1	9.2	0.7	0.1	2.0	45.9
Atmospheric sciences	100.0	38.3	8.5	0.4	0.4	2.0	50.5
Earth sciences	100.0	53.8	2.1	0.2	0.0	1.0	42.9
Oceanography	100.0	33.6	20.4	1.1	0.0	0.5	44.5
Other	100.0	15.4	11.2	2.9	0.4	12.4	57.7
Life sciences	100.0	7.0	1.8	58.0	3.7	15.4	14.1
Agricultural sciences	100.0	4.0	1.4	0.8	0.3	60.5	33.1
Biological sciences	100.0	8.1	1.7	67.3	3.1	9.4	10.5
Medical sciences	100.0	3.3	3.2	69.3	7.5	4.1	12.6
Other	100.0	4.6	1.4	50.1	21.2	0.0	22.6
Psychology	100.0	8.4	7.7	53.5	9.7	1.1	19.6
Social sciences	100.0	16.2	3.9	9.6	3.1	26.7	40.5
Anthropology	100.0	16.7	6.9	16.7	0.0	1.0	58.8
Economics	100.0	7.3	0.8	1.3	2.6	57.8	30.2
History of science	100.0	100.0	0.0	0.0	0.0	0.0	0.0
Linguistics	100.0	44.8	6.9	19.0	3.4	0.0	25.9
Political science	100.0	14.8	3.5	4.3	6.1	8.7	62.6
Sociology	100.0	18.1	0.0	31.2	7.6	19.4	23.6
Other	100.0	22.3	9.1	6.3	1.2	6.7	54.4
Total engineering	100.0	29.1	27.7	4.2	0.9	2.4	35.7
Aeronautical/							
astronautical	100.0	12.0	37.9	0.1	0.3	0.3	49.4
Chemical	100.0	42.3	10.5	5.2	1.1	4.1	36.8
Civil	100.0	28.3	14.0	1.8	0.6	3.0	52.2
Electrical/electronics	100.0	33.5	41.4	2.3	0.5	1.0	21.3
Industrial	100.0	31.9	17.9	2.7	5.4	0.0	42.2
Mechanical	100.0	24.8	29.2	2.9	0.3	0.2	42.7
Materials	100.0	31.2	31.1	0.8	0.8	0.2	35.8
Other	100.0	20.0	21.5	15.9	1.5	9.2	31.8

SOURCE: National Science Foundation, Science Resources Studies Division, Survey of Graduate Students and Postdoctorates in Science and Engineering, various years, unpublished tabulations.

See figure 5-23.

Appendix table 5-44.
U.S. scientific and technical journal articles, by sector and field: 1981-95

			Numk	Number of articles by:	s by:					Perce	Percent of articles by:	s by:		
	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other
					All natural	science an	All natural science and engineering fields	ing fields						
1981	132,280	90,412	11,141	13,099	4,791	9,959	2,883	100	89	ω	9	4	∞	2
1982	133,623	92,335	11,039	13,084	4,512	9,766	2,889	100	69	80	10	က	7	2
1983	132,416	90,556	11,760	12,880	4,627	9,932	2,665	100	89	6	10	က	ω	2
1984	131,112	90,455	11,266	12,828	4,053	9,865	2,652	100	69	<u></u>	10	က	œ	2
1985	137,771	95,340	11,767	12,899	4,917	10,188	2,662	100	69	6	6	4	7	2
1986	137,771	95,813	11,874	12,893	4,762	9,895	2,541	100	70	6	o	က	7	2
1987	134,498	94,424	11,273	12,255	4,619	9,546	2,383	100	70	ω	တ	က	7	2
1988	138,143	97,176	11,853	12,298	4,593	9,983	2,240	100	70	6	o	က	7	2
1989	140,833	99,214	11,964	12,373	4,533	10,360	2,390	100	70	œ	o	က	7	2
1990	140,994	99,498	12,296	12,379	4,403	10,065	2,356	100	71	6	တ	က	7	2
1991	142,334	100,276	12,660	12,266	4,392	10,244	2,499	100	70	0	တ	က	7	2
1992	143,175	101,781	12,423	11,986	4,319	10,149	2,523	100	71	6	ω	က	7	2
1993	140,588	100,049	11,757	11,796	3,987	10,500	2,501	100	71	ω	∞	က	7	2
1994	141,975	100,904	12,065	11,979	4,539	10,381	2,109	100	71	œ	ω	က	7	-
1995	142,792	101,458	11,791	11,858	4,792	10,755	2,141	100	71	ω	œ	က	∞	-
						Clinical medicine	nedicine							
1981	48,073	32,841	1,563	4,995	256	6,746	1,673	100	89	က	10	-	14	က
1982	48,531	33,388	1,626	5,006	235	6,554	1,722	100	69	က	10	0	4	4
1983	48,056	32,872	1,732	4,916	207	6,746	1,584	100	89	4	10	0	4	က
1984	48,736	33,319	1,860	4,992	216	6,762	1,587	100	89	4	10	0	4	က
1985	50,596	35,008	1,834	4,972	288	6,943	1,551	100	69	4	10	-	14	က
1986	50,638	34,920	2,111	5,025	254	6,788	1,542	100	69	4	10	-	13	က
1987	49,905	34,787	2,075	4,867	203	6,498	1,475	100	20	4	9	0	13	က
1988	49,932	34,722	2,146	4,846	224	6,633	1,362	100	20	4	10	0	13	က
1989	50,510	34,938	2,380	4,685	193	6,841	1,472	100	69	S)	တ	0	4	က
1990	50,322	35,058	2,477	4,623	192	6,588	1,384	100	20	2	o	0	13	က
1991	50,142	34,794	2,545	4,510	195	6,678	1,420	100	69	2	o	0	13	က
1992	50,326	35,111	2,638	4,288	179	6,618	1,493	100	20	2	o	0	13	က
1993	50,258	34,659	2,685	4,306	185	6,968	1,454	100	69	S)	တ	0	4	က
1994	49,702	34,432	2,818	4,204	236	6,798	1,215	100	69	9	∞	0	4	2
1995	50,343	34,818	2,955	4,067	230	7,021	1,253	100	69	9	80	0	14	2
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Appendix table 5-44. U.S. scientific and technical journal articles, by sector and field: 1981-95

			Number of	oer of articles by:	s by:					Perce	Percent of articles by:	s by:		
	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other
						Biomedical research	research							
1981	21,847	16,904	563	2,101	377	1,578	326	100	22	3	10	2	7	-
1982	22,732	17,704	268	2,085	336	1,702	337	100	78	2	6	_	7	-
1983	22,497	17,359	289	2,128	343	1,638	342	100	77	က	6	2	7	2
1984	22,196	17,112	771	2,044	280	1,652	338	100	77	က	6	-	7	2
1985	24,460	18,825	921	2,253	332	1,771	359	100	77	4	ග	-	7	-
1986	24,765	18,797	1,164	2,291	343	1,818	352	100	9/	2	o	-	7	-
1987	24,542	18,571	1,208	2,303	357	1,778	324	100	92	2	တ	-	7	-
1988	25,072	19,073	1,263	2,220	361	1,882	272	100	92	2	o	-	80	-
1989	26,541	20,157	1,367	2,385	357	2,015	261	100	92	2	o	-	80	-
1990	26,660	20,279	1,382	2,336	379	1,977	308	100	9/	2	6	-	7	-
1991	26,918	20,444	1,524	2,258	413	1,982	297	100	92	9	80	7	7	-
1992	27,782	21,255	1,535	2,273	360	2,050	309	100	77	9	∞	-	7	-
1993	27,119	20,686	1,508	2,276	329	2,009	310	100	92	9	∞	-	7	-
1994	27,465	20,880	1,597	2,244	358	2,121	265	100	92	9	80	-	80	-
1995	28,081	21,225	1,671	2,245	398	2,252	291	100	92	9	80	-	80	-
						Biology	ogy							
1981	14,740	11,053	332	2,221	130	553	451	100	75	2	15	-	4	က
1982	14,974	11,458	364	2,169	136	460	388	100	77	7	4	-	လ	က
1983	14,216	10,804	342	2,136	113	471	351	100	92	7	15	-	က	2
1984	14,166	10,690	412	2,123	118	455	368	100	75	က	15	-	ဇ	က
1985	13,083	10,077	383	1,792	96	398	337	100	77	က	4	-	က	က
1986	13,000	10,068	337	1,862	69	380	285	100	27	က	4	-	က	2
1987	12,231	9,547	329	1,670	72	328	255	100	78	က	4	-	က	2
1988	12,370	9,562	363	1,702	92	395	253	100	27	ო	4	-	က	2
1989	12,726	9,705	385	1,812	82	431	308	100	9/	က	4	-	က	7
1990	13,182	10,015	444	1,928	06	410	296	100	92	က	15	-	က	2
1991	12,862	9,743	439	1,875	29	422	325	100	92	က	15	0	က	က
1992	12,062	9,154	398	1,708	09	424	319	100	9/	က	4	0	4	က
1993	11,304	8,583	395	1,595	92	375	292	100	92	က	41	-	က	က
1994	11,433	8,514	491	1,710	73	381	263	100	74	4	15	-	က	7
1995	11,167	8,334	487	1,659	71	372	244	100	75	4	15	-	က	2
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Appendix table 5-44. U.S. scientific and technical journal articles, by sector and field: 1981-95

			Numk	Number of articles by:	s by:					Perce	Percent of articles by:	s by:		
	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other
						Chemistry	istry							
1981	10,880	7,647	1,798	289	437	243	89	100	70	17	9	4	2	-
1982	11,758	8,242	1,860	848	478	245	98	100	20	16	7	4	7	-
1983	11,010	7,710	1,880	716	420	214	71	100	20	17	7	4	7	-
1984	11,137	7,941	1,761	764	427	180	64	100	71	16	7	4	2	-
1985	11,585	8,137	1,951	794	418	217	89	100	20	17	7	4	7	-
1986	12,313	8,734	2,101	734	490	189	99	100	71	17	9	4	7	-
1987	11,827	8,455	2,010	694	439	182	48	100	71	17	9	4	2	0
1988	12,384	8,867	2,051	726	477	202	62	100	72	17	9	4	7	-
1989	12,405	9,025	1,960	685	490	190	55	100	73	16	9	4	2	0
1990	12,719	9,272	2,054	999	470	182	75	100	73	16	2	4	-	-
1991	13,086	9,447	2,122	669	485	239	92	100	72	16	2	4	7	-
1992	12,926	9,561	1,981	989	436	195	69	100	74	15	2	က	7	-
1993	13,252	9,789	2,045	633	443	272	20	100	74	15	2	က	7	-
1994	12,598	9,178	1,950	720	423	263	65	100	73	15	9	က	7	-
1995	12,900	9,495	1,874	669	536	248	48	100	74	15	2	4	7	0
						Physics	sics							
1981	13,053	8,123	2,135	835	1,753	180	28	100	62	16	9	13	-	0
1982	13,255	8,195	2,224	848	1,748	202	38	100	62	17	9	13	2	0
1983	13,021	8,197	2,086	760	1,727	200	51	100	63	16	9	13	7	0
1984	12,691	8,118	2,007	754	1,567	199	47	100	64	16	9	12	5	0
1985	15,903	9,802	2,823	933	2,054	234	26	100	62	18	9	13	-	0
1986	16,361	10,129	2,881	917	2,195	506	33	100	62	18	9	13	-	0
1987	16,078	10,209	2,739	854	2,006	229	42	100	63	17	2	12	-	0
1988	17,499	11,111	3,024	936	2,159	231	37	100	63	17	2	12	-	0
1989	17,649	11,392	2,915	949	2,107	245	41	100	65	17	2	12	-	0
1990	17,242	11,113	2,939	902	2,008	236	41	100	64	17	2	12	-	0
1991	18,078	11,866	2,889	1,000	2,017	249	22	100	99	16	9	1	-	0
1992	17,848	11,814	2,812	•	1,919	214	62	100	99	16	9	7	-	0
1993	16,912	11,641	2,241	066	1,757	216	89	100	69	13	9	10	-	0
1994	18,836	13,116	2,228	1,121	2,093	242	36	100	20	12	9	7	-	0
1995	17,883	12,489	1,897	1,053	2,196	202	46	100	20	=	9	12	-	0
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Appendix table 5-44. U.S. scientific and technical journal articles, by sector and field: 1981-95

			Number of	oer of articles by:	s by:					Perce	Percent of articles by:	s by:		
	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other	Total	Academia	Industry	Federal	FFRDC	Non- profit	Other
					E	Earth and space sciences	ice science	s						
1981	7,257	4,710	408	1,164	562	315	97	100	92	9	16	∞	4	-
1982	7,057	4,529	461	1,092	554	312	109	100	64	7	15	∞	4	2
1983	6,862	4,371	448	1,091	518	330	104	100	64	7	16	∞	2	2
1984	6,748	4,329	447	1,062	523	296	92	100	64	7	16	∞	4	-
1985	7,663	4,795	298	1,197	533	364	177	100	63	∞	16	7	2	7
1986	7,811	4,985	280	1,206	629	285	178	100	64	7	15	7	4	2
1987	7,797	4,984	287	1,169	268	323	166	100	64	∞	15	7	4	7
1988	7,653	4,916	516	1,120	526	418	157	100	64	7	15	7	2	2
1989	7,770	4,954	292	1,112	534	429	176	100	64	7	4	7	9	2
1990	7,716	4,941	481	1,147	548	457	142	100	64	9	15	7	9	7
1991	8,138	5,155	909	1,149	269	471	189	100	63	7	14	7	9	7
1992	8,233	5,363	296	1,149	552	416	159	100	65	7	4	7	2	7
1993	8,522	5,631	522	1,186	561	453	170	100	99	9	14	7	Ŋ	7
1994	8,904	5,826	625	1,258	621	417	158	100	92	7	14	7	2	7
1995	9,378	6,132	579	1,311	710	481	166	100	92	9	4	80	2	2
					Enç	Engineering ar	and technology	gy						
1981	12,486	5,555	4,191	1,009	1,220	283	229	100	44	34	80	10	2	2
1982	11,619	5,518	3,778	956	974	220	202	100	47	33	ω	œ	2	2
1983	13,105	5,936	4,419	1,071	1,252	270	157	100	45	34	80	10	7	-
1984	11,976	5,830	3,870	666	874	256	149	100	49	32	80	7	7	-
1985	10,822	5,442	3,081	847	1,152	198	103	100	20	28	80	7	5	-
1986	9,774	5,369	2,579	790	922	180	81	100	22	56	ω	80	2	-
1987	9,225	5,291	2,165	630	921	151	29	100	22	23	7	10	7	-
1988	9,488	5,537	2,336	099	869	171	86	100	28	25	7	7	7	-
1989	9,568	5,676	2,266	829	715	169	65	100	29	24	7	7	7	-
1990	10,113	6,084	2,402	694	229	159	86	100	09	24	7	7	7	-
1991	666'6	5,978	2,441	715	809	153	104	100	09	24	7	9	7	-
1992	10,833	6,634	2,333	808	216	176	105	100	61	22	7	7	7	-
1993	10,051	6,185	2,242	736	601	158	130	100	62	22	7	9	7	-
1994	10,058	6,210	2,262	229	693	121	94	100	62	22	7	7	-	-
1995	10,229	6,370	2,240	774	623	136	87	100	62	22	∞	9	-	-
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Appendix table 5-44. U.S. scientific and technical journal articles, by sector and field: 1981-95

			Numk	Number of articles by:	s by:					Perce	Percent of articles by:	s by:		
						Non-							Non-	
	Total	Academia Industry	Industry	Federal	FFRDC	profit	Other	Total	Academia Industry	Industry	Federal	FFRDC	profit	Other
						Mathematics	natics							
1981	3,944	3,579	151	87	56	61	=	100	91	4	2	-	2	0
1982	3,697	3,301	158	110	51	71	7	100	89	4	ო	_	7	0
1983	3,649	3,307	166	62	47	63	2	100	91	2	2	-	2	0
1984	3,462	3,116	138	06	48	65	7	100	06	4	ო	-	2	0
1985	3,659	3,254	176	111	44	63	11	100	89	2	ო	-	7	0
1986	3,109	2,811	121	89	26	49	4	100	06	4	7	2	7	0
1987	2,893	2,580	130	89	53	22	9	100	88	4	7	7	7	0
1988	3,745	3,388	154	88	53	51	=	100	06	4	7	-	-	0
1989	3,664	3,367	126	29	52	40	12	100	92	က	7	-	-	0
1990	3,040	2,736	117	80	39	26	12	100	06	4	က	-	7	0
1991	3,111	2,849	92	09	46	20	12	100	92	က	7	-	7	0
1992	3,165	2,889	130	47	37	26	7	100	91	4	-	-	7	0
1993	3,170	2,875	119	74	46	49	7	100	91	4	7	-	7	0
1994	2,979	2,748	94	45	42	38	13	100	92	က	7	-	-	0
1995	2,811	2,595	88	20	28	43	9	100	92	က	2	-	2	0

NOTE: Percentages may not total 100 because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

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Appendix table 5-45. Broad and fine fields for publications output data

Broad field		Fine fields	
Clinical medicine	Addictive diseases Allergy Anesthesiology Arthritis & rheumatism Cancer Cardiovascular system Dentistry Dermatology & venereal disease Endocrinology Fertility Gastroenterology General & internal medicine	Geriatrics Hematology Hygiene & public health Immunology Miscellaneous clinical Nephrology Neurology & neurosurgery Obstetrics & gynecology Ophthalmology Orthopedics Otorhinolaryngology	Pathology Pediatrics Pharmacology Pharmacy Psychiatry Radiology & nuclear medicine Respiratory system Surgery Tropical medicine Urology Veterinary medicine
Biomedical research	Anatomy & morphology Biochemistry & molecular biology Biomedical engineering Biophysics Cell biology, cytology & histology	Embryology Genetics & heredity General biomedical research Microbiology Microscopy	Miscellaneous biomedical research Nutrition & dietetics Parasitology Physiology Virology
Biology	Agriculture & food science Botany Dairy & animal science Ecology	Entomology General biology General zoology	Marine and hydro-biology Miscellaneous biology Miscellaneous zoology
Chemistry	Analytical chemistry Applied chemistry General chemistry	Inorganic & nuclear chemistry Organic chemistry	Physical chemistry Polymers
Physics	Acoustics Applied physics Chemical physics	Fluids & plasmas General physics Miscellaneous physics	Nuclear & particle physics Optics Solid state physics
Earth and space sciences	Astronomy & astrophysics Earth & planetary science Environmental science	Geography Geology General engineering	Meteorology & atmospheric science Oceanography & limnology Metals & metallurgy
Engineering ogy and technology	Aerospace technology Chemical engineering Civil engineering Computers Electrical engineering & electronics	Industrial engineering Library & information science Materials science Mechanical engineering	Miscellaneous engineering & technol- Nuclear technology Operations research & management
Mathematics	Applied mathematics General mathematics	Miscellaneous mathematics	Probability & statistics

SOURCE: CHI Research, Inc., Science Indicators database.

Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of multisector		articles coauthored by:	:hored by:				Percent of a	Percent of all articles coauthored by:	uthored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
				All	All natural science and engineering fields	nce and eng	ineering fie	sple					
Academia													
1981	Ϋ́	2,905	8,138	2,072	7,352	2,384	20.4	Ϋ́	2.8	7.8	2.0	7.1	2.3
1983	Ϋ́	3,386	8,234	2,160	7,798	2,429	20.9	Ϋ́Z	3.2	7.8	2.1	7.4	2.3
1985	Ϋ́	4,063	8,694	2,406	8,326	2,461	21.3	Ϋ́	3.6	7.8	2.2	7.5	2.2
1987	Ϋ́	4,598	9,104	2,684	8,286	2,477	22.1	Ϋ́	4.1	8.2	2.4	7.4	2.2
1989	Ϋ́	5,301	9,163	2,783	9,005	2,633	22.1	Ϋ́	4.5	7.8	2.4	7.6	2.2
1991	Ϋ́	6,199	9,334	3,054	9,237	2,806	22.6	Ϋ́	5.1	7.7	2.5	7.7	2.3
1993	Ϋ́	6,611	9,626	3,282	9,537	2,932	23.1	Ϋ́	5.4	7.9	2.7	7.8	2.4
1995	ΑN	7,479	10,442	3,863	10,326	2,708	24.2	Ϋ́	5.9	8.3	3.1	8.2	2.2
Industry													
1981	2,905	Ϋ́	629	248	296	172	27.3	21.6	ΝΑ	4.7	1.8	2.2	1.3
1983	3,386	Ϋ́	837	352	404	235	30.4	23.2	Ν	2.7	2.4	2.8	1.6
1985	4,063	Ϋ́	901	380	514	241	34.0	26.9	Ν	0.9	2.5	3.4	1.6
1987	4,598	Ϋ́Z	1,029	417	639	266	38.0	30.5	Ϋ́	6.8	2.8	4.2	1.8
1989	5,301	Ϋ́Z	1,215	455	814	311	40.4	32.3	Ϋ́	7.4	2.8	2.0	1.9
1991	6,199	Ϋ́Z	1,358	518	878	379	42.5	34.6	Ϋ́	7.6	2.9	4.9	2.1
1993	6,611	Ϋ́	1,565	550	1,094	464	47.0	37.8	Ϋ́	9.0	3.1	6.3	2.7
1995	7,479	Ϋ́Z	1,719	735	1,239	501	50.2	40.8	Ϋ́	9.4	4.0	6.8	2.7
Federal Government													
1981	8,138	639	Ϋ́	265	818	423	49.4	43.8	3.4	ΑN	4.1	4.4	2.3
1983	8,234	837	A A	272	838	441	50.5	44.4	4.5	Ϋ́	1.5	4.5	2.4
1985	8,694	901	Ϋ́	303	961	208	52.0	45.7	4.7	ΑN	1.6	5.0	2.7
1987	9,104	1,029	Ϋ́Z	331	985	529	55.1	48.6	5.5	ΑN	1.8	5.3	2.8
1989	9,163	1,215	Ϋ́	427	1,067	481	55.2	47.9	6.4	Ϋ́	2.2	5.6	2.5
1991	9,334	1,358	Ϋ́	419	1,173	552	55.9	48.2	7.0	Ϋ́	2.2	6.1	2.9
1993	9,626	1,565	Ϋ́	438	1,224	691	58.0	49.9	8.1	Ϋ́	2.3	6.3	3.6
1995	10,442	1,719	Ϋ́	620	1,435	618	60.2	52.2	8.6	Ϋ́	3.1	7.2	3.1
FFRDCs													
1981	2,072	248	265	A V	85	21	38.7	32.4	3.9	4.1	Ϋ́	1.3	0.3
1983	2,160	352	272	A V	107	41	41.8	33.7	5.5	4.2	Ϋ́	1.7	9.0
1985	2,406	380	303	Ϋ́	132	29	43.1	34.6	5.5	4.4	Ϋ́	1.9	0.4
1987	2,684	417	331	Ϋ́	129	35	47.2	39.0	6.1	4.8	Ϋ́	1.9	0.5
1989	2,783	455	427	Ϋ́	164	38	49.4	40.1	9.9	6.2	Ϋ́	2.4	0.5
1991	3,054	518	419	Ϋ́	207	37	52.7	43.4	7.4	0.9	Υ V	2.9	0.5
1993	3,282	220	438	A V	198	48	57.4	47.7	8.0	6.4	Ϋ́	2.9	0.7
1995	3,863	735	620	Ϋ́	279	71	55.8	45.9	8.7	7.4	Ν V	3.3	8.0
00001													

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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

Federal FFRDCs Nonprofits All others Authority Sectors Academia Authority Govt. FFRDCs Nonprofits All others Sectors Academia Authority Govt. FFRDCs Nonprofits All others Sectors S			Number of multisector a	nultisector (articles coauthored by:	thored by:				Percent of a	Percent of all articles coauthored by:	authored by:		
offits Academia Industry Govt. FFRDCs Nonprofits All others sectors Academia offits 7,782 296 818 85 NA 519 66.8 52.3 8,286 514 961 132 NA 519 66.8 52.3 9,005 814 1,067 164 NA 569 56.3 52.3 9,005 814 1,067 164 NA 569 56.3 56.3 9,005 814 1,067 1424 198 NA 767 61.1 56.3 9,005 814 1,067 1435 207 NA 767 61.1 56.3 9,037 1,024 198 NA 769 66.3 56.3 56.4 1,032 1,173 207 NA 770 82.4 56.4 56.4 2,032 461 528 27 NA 71.8 56.3 56.4				Federal				₹			Federal			
offits 7,352 296 818 85 NA 519 56.3 50.3 7,798 404 838 107 NA 519 56.8 52.3 8,286 5514 961 132 NA 515 58.1 56.3 9,005 81,286 5514 961 132 NA 515 58.9 58.9 9,007 81,284 1,087 14.73 207 NA 767 61.1 56.8 55.0 9,237 1,094 1,224 198 NA 770 62.4 56.8 56.0 10,326 1,239 1,435 279 NA 770 62.4 56.8 2,384 172 424 21 48 NA 719 59.9 2,384 172 441 481 519 NA 719 59.1 2,385 136 1,435 279 NA 70 62.4 56.8		Academia	Industry	Govt.	FFRDCs	Nonprofits	All others	sectors	Academia	Industry	Govt.	FFRDCs	Nonprofits	All others
7,382 296 818 85 NA 486 549 503 7,786 544 861 137 NA 547 561 503 8,286 539 985 129 NA 547 561 552 9,005 814 1,172 207 NA 566 59.7 55.0 9,237 1,094 1,224 198 NA 767 61.1 55.0 9,537 1,094 1,224 198 NA 770 61.1 55.0 9,537 1,094 1,224 198 NA 770 62.4 55.0 2,384 172 247 1094 1435 279 NA 62.2 51.8 2,461 240 123 2,1 486 1435 279 NA 770 62.4 56.8 2,482 235 441 41 41 519 NA 771 4148 519 NA	15													
1,788 404 888 107 NA 519 568 523 8,286 659 865 132 NA 547 58.1 53.2 8,286 659 865 129 NA 519 56.3 9,055 814 1,067 164 NA 589 59.9 54.6 1,036 1,129 1,173 207 NA 770 62.4 56.8 1,036 1,239 1,435 279 NA 770 62.4 56.8 2,487 2,461 241 241 41 519 NA 66.2 54.4 2,461 241 508 29 547 NA 66.3 54.8 2,461 241 508 29 547 NA 66.3 54.8 2,462 2,382 441 41 519 NA 66.3 54.8 2,463 379 552 37 767 NA 719 59.9 2,708 379 552 37 767 NA 719 59.9 2,708 379 552 37 767 NA 719 59.9 3,70 4,718 166 6,072 1,718 29.6 NA NA 1,584 4,718 166 6,072 1,718 29.6 NA NA 1,880 4,718 166 6,072 1,783 29.6 NA NA 1,880 4,718 166 6,072 1,718 30.5 NA NA 1,880 4,718 166 6,072 1,718 30.5 NA NA 1,880 4,718 166 6,072 1,718 30.5 NA NA 1,880 4,718 167 6,219 1,911 30.5 NA NA 1,880 4,718 167 6,219 1,911 30.5 NA NA 1,880 4,718 166 6,072 1,718 30.5 NA NA 1,880 4,718 167 6,219 1,911 30.5 NA NA 1,880 4,718 1,818 1,822 31.3 NA NA 1,880 4,718 167 6,219 1,911 30.5 NA NA 1,880 4,718 168 6,507 2,004 30.8 NA 2,457 4,791 2,29 6,700 1,822 31.3 NA 1,322 NA 391 38 385 152 54.4 45.3 1,584 NA 353 37 516 6,507 54.4 45.3 1,584 NA 345 345 345 345 345 345 345 1,584 NA 345 345 345 345 345 345 1,584 345 345 345 345 34		7,352	296	818	85	Ϋ́	486	54.9	50.3	2.0	5.6	9.0	Ϋ́	3.3
8,326 514 961 132 NA 547 581 532 8,086 639 995 129 NA 569 599 590 9,237 878 1,173 207 NA 767 61.1 553 10,326 1,239 1,435 279 NA 770 62.4 568 2,461 241 508 29 547 NA 65.5 544 2,461 241 508 29 547 NA 65.5 544 2,461 241 508 29 547 NA 65.5 544 2,467 2,66 529 35 547 NA 65.5 544 2,477 2,66 529 37 767 NA 71.8 598 2,806 379 552 37 767 NA 71.8 598 2,806 379 552 37 767 NA 71.8 599 2,708 636 4,69 119 5,49 11,712 30.5 NA NA 1,884 4,789 161 6,177 1,881 30.5 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA 1,522 NA 488 35 16 540 193 492 32.5 1,522 NA 488 35 37 516 52.9 42.1 1,522 NA 488 35 37 516 52.9 42.1 1,522 NA 488 35 37 516 52.9 44.1 1,524 NA 488 35 37 516 55.1 2,007 NA 488 55 516 50.1 56.1 2,007 NA 488 42 771 56 52.9 44.1 1,524 NA 488 42 771 56 52.9 44.1 1,525 NA 488 42 771 56 52.9 54.1 2,007 NA 488 42 771 66 52.0 54.1 2,007 NA 488 42 771 66 52.0 54.1 2,007 NA 488 42 771 66 52.7 54.1 2,008 NA 468 42 771 66 56.7 54.1 2,008 NA 468 42 771 66 56.7 54.1 2,008 NA 468 42 771 66 56.7 66		7,798	404	838	107	Ϋ́	519	56.8	52.3	2.7	5.6	0.7	Ϋ́	3.5
8,286 639 985 129 NA 515 55.0 55.0 9,237 878 1,067 164 NA 765 55.0 55.0 9,237 878 1,094 1,224 198 NA 770 61.1 55.3 9,537 1,094 1,224 198 NA 861 60.9 55.1 10,326 1,239 1,435 279 NA 861 60.9 55.1 2,384 172 423 21 486 NA 62.2 51.8 2,429 2,38 441 41 41 41 41 519 NA 62.2 54.4 2,429 2,38 441 41		8,326	514	961	132	Ϋ́	547	58.1	53.2	3.3	6.1	0.8	ΑN	3.5
9,005 814 1,067 164 NA 589 59.9 54.6 9,237 1034 1,173 207 NA 767 61.1 55.3 10,326 1,1239 1,435 279 NA 777 62.4 56.8 10,326 1,239 1,435 279 NA 777 62.4 56.8 2,429 235 441 41 519 NA 65.5 54.4 2,429 235 441 41 519 NA 65.5 54.4 2,429 235 441 41 519 NA 65.5 54.4 2,429 235 341 481 38 589 NA 71.8 59.8 2,806 379 552 37 767 NA 73.4 59.9 2,902 464 691 48 861 NA 75.8 59.9 NA 779 4469 130 5,738 1,763 29.6 NA NA 1,822 4,938 157 6,178 1,911 30.3 NA 1,804 4,718 166 6,072 1,763 29.6 NA NA 1,804 4,718 168 6,507 2,004 30.6 NA 1,804 NA 2,102 4,731 1,574 28 278 1,913 30.5 NA 1,322 NA 2,457 4,791 2,29 6,700 1,822 31.3 NA 1,322 NA 2,457 4,791 2,89 278 103 4,20 39.6 1,914 1,930 NA 2,457 4,791 2,89 278 103 4,20 39.6 1,914 1,930 NA 2,457 2,47 2,8 278 103 4,20 39.6 1,914 1,930 NA 2,457 2,47 2,8 278 103 4,20 39.6 1,914 1,930 NA 2,457 2,8 2,8 2,2 2,4 4,5 2,1 2,1 2,1 2,1 2,1 2,1 2,1 2,1 2,1 2,1		8,286	639	985	129	Ϋ́	515	59.7	55.0	4.2	6.5	0.9	Ϋ́	3.4
9,237 878 1,173 207 NA 767 61.1 55.3 1,0326 1,239 1,435 279 NA 770 62.4 56.8 2,384 172 423 21 486 NA 65.5 54.4 2,429 235 441 41 41 519 NA 65.5 54.4 2,477 266 529 35 515 NA 65.3 54.8 2,633 311 481 38 589 NA 77.8 59.8 2,032 464 691 77 NA 77.9 59.8 2,032 464 691 77 NA 77.9 59.8 2,032 464 691 77 NA 77.9 59.8 NA 1,322 4,469 130 5,738 1,752 29.6 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880 NA 1,880 4,611 157 6,219 1,911 30.3 NA 1,880		9,005	814	1,067	164	Ϋ́	589	59.9	54.6	4.9	6.5	1.0	Ϋ́	3.6
9,537 1,094 1,224 198 NA 861 60.9 55.1 2,384 172 423 21 486 NA 62.2 51.8 2,429 235 441 41 519 NA 65.5 54.4 2,421 247 266 529 35 547 NA 66.3 54.3 2,477 266 529 35 547 NA 69.7 58.4 2,633 311 481 38 589 NA 71.9 59.9 2,633 311 481 38 589 NA 71.9 59.9 2,102 4,698 119 5,479 1,718 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,322 4,993 157 6,204 30.8 NA NA 1,884 4,719 161 6,177 1,881 30.5 NA NA 1,884 4,719 161 6,177 1,881 30.5 NA 1,184 4,79 161 6,177 1,881 30.5 NA 1,182 NA 1,180 NA 2,457 4,791 229 6,700 1,822 31.3 NA 1,132 NA 1,134 NA 1,134 NA 1,135 NA 1,136		9,237	878	1,173	207	Ϋ́	292	61.1	55.3	5.3	7.0	1.2	ΑN	4.6
10,326		9,537	1,094	1,224	198	Ϋ́	861	6.09	55.1	6.3	7.1	1.1	Ϋ́	2.0
2,384 172 423 21 486 NA 65.5 51.8 2,429 235 441 41 519 NA 65.5 54.4 2,461 241 508 29 547 NA 66.5 54.4 2,477 266 529 35 515 NA 69.7 58.4 2,863 311 481 38 589 NA 71.9 59.8 2,802 464 691 48 861 NA 73.4 59.9 2,708 501 618 71 770 NA 73.4 59.9 NA 1,080 4,718 166 6,072 1,762 29.6 NA 1,080 4,718 166 6,072 1,763 29.6 NA 1,322 4,933 157 5,948 1,802 30.1 NA 1,380 4,611 157 6,219 1,911 30.3 NA 1,322 4,93 157 6,219 1,911 30.3 NA 1,322 4,53 158 6,507 2,004 30.8 NA 1,322 4,53 158 6,507 2,004 30.8 NA 1,322 4,731 229 6,700 1,822 31.3 NA 1,080 NA 2,457 4,791 229 6,700 1,822 31.3 NA 1,322 NA 193 10 240 103 42.2 32.5 1,22 NA 1,322 NA 193 10 240 103 42.2 32.5 1,22 NA 1,322 NA 1,333 222 54.4 45.3 1,884 35.3 37 212 54.4 45.3 1,884 35.3 37 37 37 37 37 37 37 37 37 37 37 37 37		10,326	1,239	1,435	279	Ϋ́	770	62.4	56.8	8.9	7.9	1.5	Ϋ́	4.2
2,384 172 423 21 486 NA 65.5 51.8 2,429 235 441 41 519 NA 65.5 54.4 2,476 2,476 266 529 35 515 NA 69.7 58.4 2,476 2,476 2,633 311 481 38 589 NA 71.9 59.8 2,633 311 481 38 589 NA 71.9 59.8 2,806 379 552 37 767 NA 71.9 59.9 2,806 379 552 37 767 NA 71.9 59.9 2,932 464 691 71 770 NA 77.9 4.69 130 5,479 1,718 59.9 NA NA 1,080 4,718 166 6,072 1,762 29.6 NA NA 1,380 4,611 157 6,194 1,911 30.5 NA NA 1,080 4,611 157 6,219 1,911														
2,429 235 441 41 519 NA 66.5 54.4 2,461 241 508 29 547 NA 66.3 54.3 2,461 247 266 529 35 555 NA 71.8 59.8 2,633 311 481 38 589 NA 71.8 59.8 2,806 379 552 37 767 NA 71.9 59.9 2,806 379 552 37 767 NA 71.9 59.9 2,932 464 691 48 861 NA 71.9 59.9 2,932 464 691 48 861 NA 71.9 59.9 2,932 464 691 48 861 NA 71.9 59.9 3,708 461 171 770 NA 75.8 62.2 1 NA 779 468 130 5,738 1,752 </td <td></td> <td>2,384</td> <td>172</td> <td>423</td> <td>21</td> <td>486</td> <td>Ϋ́</td> <td>62.2</td> <td>51.8</td> <td>3.7</td> <td>9.2</td> <td>0.5</td> <td>10.6</td> <td>Ϋ́</td>		2,384	172	423	21	486	Ϋ́	62.2	51.8	3.7	9.2	0.5	10.6	Ϋ́
2,461 241 508 29 547 NA 66.3 54.3 2,477 266 529 35 515 NA 69.7 58.4 2,633 311 481 38 589 NA 71.8 59.8 2,806 379 522 37 76 NA 71.9 59.9 2,806 379 618 71 770 NA 71.9 59.9 2,806 379 618 71 770 NA 77.9 59.9 2,806 379 618 71 770 NA 75.8 62.2 7 NA 779 4,698 119 5,479 1,762 29.6 NA NA 1,380 4,611 157 5,498 1,66 70 1,81 NA NA 1,580 4,611 157 6,219 1,911 30.5 NA NA 1,880 4,611 157		2,429	235	441	4	519	ΥN	65.5	54.4	5.3	6.6	6.0	11.6	Α
2,477 266 529 35 515 NA 69.7 58.4 59.8 2.633 311 481 38 589 NA 71.8 59.8 59.8 NA 51.9 59.8 59.9 NA 71.9 59.9 59.9 52.932 464 691 48 861 NA 770 NA 770 NA 770 A469 130 5.738 1.752 29.6 NA NA 1,080 4,718 166 6,072 1,763 29.6 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,080 4,011 157 6,219 1,101 30.3 NA NA 1,080 4,011 157 6,219 1,011 30.3 NA NA 1,222 4,993 167 6,219 1,011 30.3 NA NA 2,102 4,636 161 6,770 1,822 31.3 NA NA 1,080 NA 158 6,507 2,004 30.8 NA 1,080 NA 158 10 229 6,700 1,822 31.3 NA 1,080 NA 158 10 2240 103 42.2 32.5 11.080 NA 247 28 278 1103 42.2 32.5 11.080 NA 247 28 278 1103 42.2 32.5 11.080 NA 415 29 533 222 54.4 45.3 11.880 NA 468 42 701 266 55.7 46.2		2,461	241	208	29	547	Ϋ́	66.3	54.3	5.3	11.2	9.0	12.1	Ϋ́
2,6633 311 481 38 589 NA 71.8 59.8 2,806 379 552 37 767 NA 71.9 59.9 2,806 379 552 37 767 NA 71.9 59.9 2,932 464 691 48 861 NA 73.4 59.9 NA 636 4,698 119 5,479 1,718 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA 1,584 4,789 161 6,177 1,881 30.5 NA 1,584 4,791 229 6,700 1,813 30.3 NA 1,584 4,791 229 6,700 1,822 31.3 NA 1,108 NA 1,584 4,791 229 6,700 1,822 31.3 NA 1,108 NA 1,584 4,791 229 6,700 1,822 31.3 NA 1,108 NA 1,584 4,791 229 6,700 1,822 31.3 NA 1,108		2,477	266	529	35	515	Ϋ́	69.7	58.4	6.3	12.5	0.8	12.1	Ϋ́
2,806 379 552 37 767 NA 71.9 59.9 2,932 464 691 48 861 NA 73.4 59.9 2,932 464 691 48 861 NA 73.4 59.9 2,708 501 618 71 770 NA 779 4,69 119 5,479 1,718 29.6 NA NA 1,880 4,611 157 6,191 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 1,080 4,791 229 6,700 1,822 31.3 NA NA 1,080 NA 151 14 173 2,004 30.8 NA NA 1,080 4,791 229 6,700 1,822 31.3 NA NA 1,080 NA 151 14 173 72 39.0 30.5 17.8 NA 1,080 NA 151 14 173 72 39.0 30.5 17.8 NA 1,080 NA 1532 NA 154 4,791 229 6,700 1,822 31.3 NA 1,322 NA 154 154 154 154 154 154 154 154 154 154		2,633	311	481	38	589	ΥN	71.8	59.8	7.1	10.9	6.0	13.4	Α
2,932 464 691 48 861 NA 73,4 59.9 2,708 501 618 71 770 NA 75.8 62.2 1 NA 5078 501 178 29.6 NA 62.2 1 NA 779 4,469 130 5,738 1,752 29.6 NA NA 1,080 4,718 166 6,072 1,763 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,584 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,611 157 6,219 1,911 30.3 NA NA 2,457 4,791 229 <		2,806	379	552	37	797	Ϋ́	71.9	59.9	8.1	11.8	0.8	16.4	Ϋ́
Cy708 501 618 71 770 NA 75.8 62.2 1 NA 636 4,698 119 5,479 1,718 29.6 NA NA 1,080 4,718 166 6,072 1,762 29.6 NA NA 1,322 4,993 157 5,948 1,763 29.6 NA NA 1,322 4,993 161 6,177 1,881 30.5 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA 1,080 NA 193 10		2,932	464	691	48	861	ΑN	73.4	59.9	9.2	14.1	1.0	17.6	ΑN
Clinical medicine NA 636 4,698 119 5,479 1,718 29.6 NA NA 1,080 4,718 130 5,738 1,752 29.6 NA NA 1,080 4,718 166 6,072 1,763 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,102 4,636 158 6,700 1,822 31.3 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA 1,080 NA 193 10 240 103 49.0 39.6 1,584 N		2,708	501	618	71	770	Υ V	75.8	62.2	11.5	14.2	1.6	17.7	Ν
NA 636 4,698 119 5,479 1,718 29.6 NA NA 1,080 4,718 166 6,072 1,763 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA NA 2,457 2,79 NA 193 10 240 103 42.2 32.5 1,080 NA 247 28 278 103 49.0 39.6 1,322 NA 301 38 385 152 51.2 41.5 1,584 NA 353 37 516 165 52.9 42.1 1,880 NA 415 29 533 222 54.4 45.3 2,102 NA 468 42 701 266 55.7 46.2						悥	nical medici	ne						
NA 636 4,698 119 5,479 1,718 29.6 NA NA 779 4,469 130 5,738 1,752 29.6 NA NA 1,080 4,718 166 6,072 1,763 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA MA 2,457 4,791 229 6,700 1,822 31.3 NA MA 1,080 NA 193 10 240 103 42.2 32.6 MA 1,322 NA 30.6														
NA 779 4,469 130 5,738 1,752 29.6 NA NA 1,080 4,718 166 6,072 1,763 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA MA 2,457 4,791 229 6,700 1,822 31.3 NA MA 2,457 4,791 229 6,700 1,822 31.3 NA MA 1,080 NA 193 10 240 103 42.2 32.6 MA 1,322 NA 30.8 <td></td> <td>Ϋ́</td> <td>636</td> <td>4,698</td> <td>119</td> <td>5,479</td> <td>1,718</td> <td>29.6</td> <td>₹</td> <td>1.6</td> <td>12.0</td> <td>0.3</td> <td>14.0</td> <td>4.4</td>		Ϋ́	636	4,698	119	5,479	1,718	29.6	₹	1.6	12.0	0.3	14.0	4.4
NA 1,080 4,718 166 6,072 1,763 29.6 NA NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,102 4,791 229 6,700 1,822 31.3 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA S NA 151 14 173 72 39.0 30.5 MA 1,080 NA 247 28 278 103 49.0 39.6 MA 1,322 NA 30.1 38 385 152 51.2 41.5 MA 1,584 NA 363 37 516 165 52.9 42.1 MA 1,880 <td></td> <td>ΑN</td> <td>779</td> <td>4,469</td> <td>130</td> <td>5,738</td> <td>1,752</td> <td>29.6</td> <td>Ϋ́</td> <td>2.0</td> <td>11.3</td> <td>0.3</td> <td>14.5</td> <td>4.4</td>		ΑN	779	4,469	130	5,738	1,752	29.6	Ϋ́	2.0	11.3	0.3	14.5	4.4
NA 1,322 4,993 157 5,948 1,802 30.1 NA NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA MA 2,457 4,791 229 6,700 1,822 31.3 NA MA 2,457 4,791 229 6,700 1,822 31.3 NA MA 153 10 240 1,822 31.3 NA MA 193 10 240 103 42.2 32.5 MA 247 28 278 103 49.0 39.6 MA 363 37 516 165 52.9 42.1 MA 415 29 533 222 54.4 45.3 MA		ΑN	1,080	4,718	166	6,072	1,763	29.6	Ϋ́	2.6	11.2	0.4	14.4	4.2
NA 1,584 4,789 161 6,177 1,881 30.5 NA NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,102 4,791 229 6,700 1,822 31.3 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA NA 151 14 173 72 39.0 30.5 NA 193 10 240 103 42.2 32.5 1,080 NA 247 28 278 103 49.0 39.6 1,322 NA 301 38 385 152 51.2 41.5 1,584 NA 415 29 533 222 54.4 45.3 1,880 NA 468 42 701 266 55.7 46.2		ΑN	1,322	4,993	157	5,948	1,802	30.1	Ϋ́	3.1	11.8	0.4	14.1	4.3
NA 1,880 4,611 157 6,219 1,911 30.3 NA NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,102 4,791 229 6,700 1,822 31.3 NA NA 151 14 173 72 39.0 30.5 NA 193 10 240 103 42.2 32.5 1,080 NA 247 28 278 103 49.0 39.6 1,322 NA 301 38 385 152 51.2 41.5 1,584 NA 353 37 516 165 52.9 42.1 1,880 NA 415 29 533 222 54.4 45.3 1,880 NA 468 42 701 266 55.7 46.2		ΑN	1,584	4,789	161	6,177	1,881	30.5	Ϋ́	3.7	11.3	0.4	14.5	4.4
NA 2,102 4,636 158 6,507 2,004 30.8 NA NA 2,457 4,791 229 6,700 1,822 31.3 NA Sign NA 151 14 173 72 39.0 30.5 NA 193 10 240 103 42.2 32.5 Sign NA 247 28 278 103 49.0 39.6 Sign NA 301 38 385 152 51.2 41.5 Sign NA 353 37 516 165 52.9 42.1 Sign NA 415 29 533 222 54.4 45.3 Sign 2102 NA 468 42 701 266 55.7 46.2		ΑN	1,880	4,611	157	6,219	1,911	30.3	Ϋ́	4.4	10.8	0.4	14.6	4.5
MA 2,457 4,791 229 6,700 1,822 31.3 NA 636 NA 151 14 173 72 39.0 30.5 779 NA 193 10 240 103 42.2 32.5 1,080 NA 247 28 278 103 49.0 39.6 1,322 NA 301 38 385 152 51.2 41.5 1,584 NA 353 37 516 165 52.9 42.1 1,880 NA 415 29 533 222 54.4 45.3 1,102 NA 468 42 701 266 55.7 46.2		ΑN	2,102	4,636	158	6,507	2,004	30.8	Ϋ́	4.9	10.8	0.4	15.2	4.7
636 NA 151 14 173 72 39.0 30.5 779 NA 193 10 240 103 42.2 32.5 1,080 NA 247 28 278 103 49.0 39.6 1,322 NA 301 38 385 152 51.2 41.5 1,584 NA 353 37 516 165 52.9 42.1 1,880 NA 415 29 533 222 54.4 45.3 2,102 NA 468 42 701 266 55.7 46.2		Ϋ́	2,457	4,791	229	6,700	1,822	31.3	Ą	5.6	11.0	0.5	15.4	4.2
636 NA 151 14 173 72 39.0 30.5 779 NA 193 10 240 103 42.2 32.5 1,080 NA 247 28 278 103 49.0 39.6 1,322 NA 301 38 385 152 51.2 41.5 1,584 NA 353 37 516 165 52.9 42.1 1,880 NA 468 42 701 266 55.7 46.2														
779 NA 193 10 240 103 42.2 32.5 1,080 NA 247 28 278 103 49.0 39.6 1,322 NA 301 38 385 152 51.2 41.5 1,584 NA 353 37 516 165 52.9 42.1 1,880 NA 415 29 533 222 54.4 45.3 2,102 NA 468 42 701 266 55.7 46.2		636	Ϋ́	151	4	173	72	39.0	30.5	Υ V	7.2	0.7	8.3	3.5
		779	ΑN	193	10	240	103	42.2	32.5	ΑN	8.1	0.4	10.0	4.3
		1,080	N A	247	28	278	103	49.0	39.6	ΑN	9.1	1.0	10.2	3.8
		1,322	Ϋ́	301	38	385	152	51.2	41.5	A V	9.5	1.2	12.1	4.8
		1,584	N A	353	37	516	165	52.9	42.1	ΑN	9.4	1.0	13.7	4.4
		1,880	N A	415	29	533	222	54.4	45.3	ΝΑ	10.0	0.7	12.8	5.3
		2,102	N A	468	42	701	266	55.7	46.2	ΝΑ	10.3	6.0	15.4	2.8
NA 509 51 786 317 56.9 47.7		2,457	Ϋ́	209	51	286	317	56.9	47.7	Ν A	6.6	1.0	15.3	6.2

Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of r	nultisector	Number of multisector articles coauthored by:	thored by:				Percent of all articles coauthored by:	l articles co	authored by:		
-	-	-	Federal	(((()	2	=	₹.	-	-	Federal			=
Sector	Academia	Industry	Govt.	FFRDCs	Nonprofits	All others	sectors	Academia	Industry	Govt.	FFRDCs	Nonprofits	All others
Federal Government													
1981	4,698	151	Α	28	556	273	63.5	59.1	1.9	Ä	0.4	7.0	3.4
1983	4,469	193	Α	28	584	279	62.1	57.4	2.5	Ä	0.4	7.5	3.6
1985	4,718	247	Ϋ́	48	658	347	63.5	58.1	3.0	Ϋ́	9.0	8.1	4.3
1987	4,993	301	¥	53	661	359	65.7	6.09	3.7	¥	9.0	8.1	4.4
1989	4,789	353	Α	64	069	334	65.8	60.2	4.4	Ä	0.8	8.7	4.2
1991	4,611	415	¥	53	718	351	65.3	59.3	5.3	¥	0.7	9.2	4.5
1993	4,636	468	¥	22	773	438	2.99	60.3	6.1	¥	0.7	10.1	5.7
1995	4,791	209	¥	94	929	408	69.5	62.9	6.7	¥	1.2	12.2	5.4
FFRDCs													
1981	119	41	58	Ϋ́	21	2	45.6	33.5	3.9	7.9	Ϋ́	5.9	4.1
1983	130	10	58	Ϋ́	28	2	53.5	41.7	3.2	9.0	Ϋ́	9.0	1.6
1985	166	28	48	Ϋ́Z	43	9	53.6	38.3	6.5	11.1	Ϋ́	6.6	4.1
1987	143	16	34	Ϋ́	34	10	55.2	42.4	4.7	10.1	Ϋ́	10.1	3.0
1989	157	38	23	Ϋ́	26	4	58.8	45.5	11.0	15.4	Ϋ́	7.5	1.2
1991	161	37	64	Ϋ́	32	12	64.5	46.5	10.7	18.5	Ϋ́	9.2	3.5
1993	157	29	23	Ϋ́	36	7	62.0	45.9	8.5	15.5	Ϋ́	10.5	2.0
1995	158	42	22	Ϋ́	30	4	6.99	45.1	12.0	16.3	Ϋ́	8.6	1.
Nonprofits													
1981	5,479	173	226	25	Ϋ́	403	58.3	54.4	1.7	2.5	0.2	ΑN	4.0
1983	5,738	240	584	28	N A	438	59.9	56.1	2.3	2.5	0.3	Ϋ́	4.3
1985	6,072	278	658	43	Ϋ́	461	60.7	56.6	2.6	6.1	0.4	ΑN	4.3
1987	5,948	385	661	26	Ϋ́	452	62.0	58.0	3.8	6.4	0.3	ΑN	4.4
1989	6,177	516	069	32	Ϋ́	482	61.7	57.0	4.8	6.4	0.3	Ϋ́	4.5
1991	6,219	533	718	36	Ϋ́	627	62.7	57.8	5.0	6.7	0.3	Ϋ́	5.8
1993	6,507	701	773	30	Ϋ́	727	62.1	57.5	6.2	8.9	0.3	ΑN	6.4
1995	6,700	786	929	40	N A	643	65.9	67.9	6.8	8.0	0.3	Ϋ́	5.6
Other													
1981	1,718	72	273	9	403	Ϋ́	69.5	59.6	2.5	9.5	0.2	14.0	Ϋ́
1983	1,752	103	279	2	438	ΑN	71.8	62.0	3.6	6.6	0.2	15.5	Ϋ́
1985	1,763	103	347	9	461	ΑN	73.5	62.0	3.6	12.2	0.2	16.2	Ϋ́
1987	1,802	152	329	4	452	ΑN	74.9	64.6	5.5	12.9	0.1	16.2	Ϋ́
1989	1,881	165	334	12	482	ΑN	9.92	65.5	5.7	11.6	0.4	16.8	Ϋ́
1991	1,911	222	351	7	627	ΑN	78.1	66.4	7.7	12.2	0.2	21.8	Ϋ́
1993	2,004	266	438	4	727	ΑN	77.8	66.2	8.8	14.5	0.1	24.0	Ϋ́
1995	1,822	317	408	14	643	ΑN	80.1	8.99	11.6	15.0	0.5	23.6	Ϋ́

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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of multisector	multisector	articles coauthored by:	thored by:				Percent of a	Percent of all articles coauthored by:	authored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
					Biom	Biomedical research	arch						
Academia													
1981	Ϋ́	276	1,270	202	1,175	236	15.7	Ϋ́	1.5	6.7	1.1	6.2	1.2
1983	Ϋ́	334	1,316	181	1,296	269	16.1	ΑN	1.7	6.7	6.0	9.9	4.1
1985	ΑN	534	1,578	200	1,564	301	17.8	ΑN	2.5	7.3	6.0	7.3	4.1
1987	Ϋ́	718	1,652	223	1,610	301	19.1	ΑN	3.3	7.7	1.0	7.5	4.1
1989	Ϋ́	790	1,815	243	1,920	318	19.6	ΑN	3.4	7.7	1.0	8.2	4.1
1991	ΑN	935	1,772	323	1,959	376	20.0	ΑN	3.9	7.3	1.3	8.1	1.6
1993	Ϋ́	1,045	1,825	303	2,000	361	20.1	Ą	4.2	7.4	1.2	8.1	1.5
1995	Ϋ́	1,216	2,013	395	2,393	378	22.1	ΑΝ	4.7	7.8	1.5	9.3	1.5
Industry													
1981	276	Ą	22	20	40	14	43.4	35.3	ΑN	7.3	2.6	5.1	1.8
1983	334	ΑN	92	18	62	20	44.5	34.6	ΑN	8.6	1.9	6.4	2.1
1985	534	ΑN	146	22	06	31	48.3	38.8	ΑN	10.6	1.6	6.5	2.3
1987	718	Ϋ́	191	33	135	28	49.0	39.6	ΑN	10.5	1.8	7.5	1.5
1989	790	ΑN	208	41	163	35	47.0	38.8	ΑN	10.2	2.0	8.0	1.7
1991	935	ΑN	205	51	186	31	48.7	40.1	ΑN	8.8	2.2	8.0	1.3
1993	1,045	Ϋ́	227	48	222	42	52.1	43.2	ΑN	9.4	2.0	9.2	1.7
1995	1,216	Ϋ́	229	56	284	20	52.9	44.1	ΑN	8.3	2.0	10.3	1.8
Federal Government													
1981	1,270	22	Ϋ́Z	48	145	35	47.7	42.6	1.9	Ν	1.6	4.9	1.2
1983	1,316	92	Ϋ́	38	135	46	48.1	43.2	3.1	Ϋ́	1.2	4.4	1.5
1985	1,578	146	Ϋ́Z	63	165	54	51.7	46.7	4.3	ΑN	1.9	4.9	1.6
1987	1,652	191	Ϋ́Z	71	198	46	53.0	46.9	5.4	Ν	2.0	5.6	1.3
1989	1,815	208	Ϋ́	92	216	39	54.0	48.1	5.5	Ϋ́	2.4	2.7	1.0
1991	1,772	205	Ϋ́	92	253	22	55.8	48.5	5.6	Ϋ́	5.6	6.9	1.5
1993	1,825	227	Ϋ́	72	225	80	54.8	48.9	6.1	Ϋ́	1.9	0.9	2.1
1995	2,013	229	Ϋ́	102	248	73	58.1	52.4	0.9	Ϋ́	2.7	6.5	1.9
FFRDCs													
1981	202	20	48	Ϋ́	21	ო	47.1	38.0	3.8	0.6	Ϋ́	4.0	9.0
1983	181	18	38	Ϋ́	27	1	44.9	37.3	3.7	7.8	Ϋ́	5.6	2.3
1985	200	22	63	Ϋ́	26	ω	52.7	39.9	4.4	12.6	Ϋ́	5.2	1.6
1987	223	33	71	Ϋ́	27	12	55.3	39.9	5.9	12.7	Ϋ́	4.8	2.1
1989	243	4	92	Ϋ́	25	ω	55.6	41.7	7.0	15.8	Ϋ́	4.3	4.1
1991	323	51	92	Ϋ́	22	ω	59.4	46.1	7.3	13.6	Ϋ́	6.7	- -
1993	303	48	72	Ϋ́	42	80	64.2	20.7	8.0	12.0	Ϋ́	7.0	1.3
1995	395	26	102	Ϋ́	80	œ	64.3	52.2	7.4	13.5	¥	10.6	1.1
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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

Sector													
			Federal				¥			Federal			
	Academia	Industry	Govt.	FFRDCs	Nonprofits	All others	sectors	Academia	Industry	Govt.	FFRDCs	Nonprofits	All others
Nonprofits													
1981	1,175	40	145	20	ΑN	53	55.3	49.7	1.7	6.1	0.8	Ϋ́Z	2.2
1983	1,296	62	135	27	ΑN	51	55.7	51.3	2.5	5.3	1:1	Ϋ́	2.0
1985	1,564	06	165	26	ΑN	26	59.5	55.0	3.2	5.8	6.0	Ϋ́Z	2.0
1987	1,610	135	198	27	ΑN	46	60.1	55.1	4.6	6.8	0.9	ΑN	1.6
1989	1,920	163	216	25	ΑN	73	61.7	57.1	4.8	6.4	0.7	Ϋ́	2.2
1991	1,959	186	253	55	Ν	91	63.4	57.5	5.5	7.4	1.6	Ϋ́Z	2.7
1993	2,000	222	225	42	ΑN	78	62.4	57.1	6.3	6.4	1.2	Ϋ́Z	2.2
1995	2,393	284	248	80	ΑN	89	64.6	59.5	7.1	6.2	2.0	ΥZ	2.2
Other													
1981	236	41	32	2	53	Ϋ́Z	56.0	47.2	2.8	7.0	1.0	10.6	Ν Α
1983	269	20	46	7	51	Ϋ́	59.0	49.6	3.7	8.5	2.0	9.4	Ϋ́
1985	301	31	54	∞	26	Ϋ́Z	58.9	51.3	5.3	9.2	1.4	9.5	Ϋ́
1987	301	28	46	12	46	Ϋ́Z	64.0	54.2	5.0	8.3	2.2	8.3	Ϋ́
1989	318	35	39	ω	73	Ϋ́	71.4	62.7	6.9	7.7	1.6	14.4	Ϋ́
1991	376	31	22	ω	91	Ϋ́	72.9	63.6	5.2	9.3	1.4	15.4	Ϋ́
1993	361	42	80	∞	78	Ϋ́Z	70.9	59.1	6.9	13.1	1.3	12.8	Ϋ́
1995	378	20	73	80	88	Ϋ́	72.7	62.6	8.3	12.1	1.3	14.7	Ϋ́
						Biology							
Academia													
1981	Ϋ́	176	829	49	221	262	12.2	Ϋ́	1.5	6.9	0.4	1.8	2.2
1983	Ϋ́	210	1,024	48	247	213	13.8	Ϋ́	1.8	8.6	0.4	2.1	1.8
1985	Ϋ́	242	852	20	194	202	13.1	Ϋ́	2.2	7.6	0.4	1.7	1.8
1987	Ϋ́	204	871	58	182	163	13.2	Ϋ́	1.9	8.2	0.5	1.7	1.5
1989	Ϋ́	285	902	20	232	242	14.7	Ϋ́	2.6	8.2	0.5	2.1	2.2
1991	Ϋ́	296	686	45	225	234	15.0	Ϋ́Z	2.7	8.9	0.4	2.0	2.1
1993	Ϋ́	316	894	29	213	252	16.2	Ϋ́	3.2	8.9	9.0	2.1	2.5
1995	Ν A	386	1,020	69	254	210	18.0	Ϋ́	3.9	10.4	0.7	2.6	2.1
Industry													
1981	176	Ϋ́	4	S	9	13	46.9	38.9	Ϋ́	9.1	1.	1.3	2.9
1983	210	Ϋ́	70	13	13	18	54.2	42.0	Ϋ́	14.0	2.6	2.6	3.6
1985	242	Ϋ́	20	Ŋ	7	21	50.5	43.8	Ϋ́	9.0	6.0	. ნ.	3.8
1987	204	Ϋ́	36	7	<u></u>	13	47.0	40.6	Ϋ́	7.2	0.4	1.8	2.6
1989	285	Ą	28	<u></u>	=	21	57.1	47.9	ΑN	9.7	1.5	1.8	3.5
1991	296	Ϋ́	72	က	13	21	52.8	45.1	Ϋ́	11.0	0.5	2.0	3.2
1993	316	Ϋ́Z	89	9	18	19	0.09	49.4	Ϋ́Z	13.9	6.0	2.8	3.0
1995	386	A A	86	80	23	28	57.3	49.3	Ϋ́	12.5	1.0	2.9	3.6

Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of r	nultisector a	Number of multisector articles coauthored by:	thored by:				Percent of all articles coauthored by:	l articles coa	authored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
Federal Government	CC	7	\$	7	oc	ű	о 1	0	ų	<u> </u>	2	7	2
1083	1027	- t	ξ <u> </u>		0 7 7	9 6	23.3 0 0 0 0	28.9 28.5	- с 5 п	(<u> </u>		 - «	, с 1. п
1985	,021 850	2 6	Ç	2	5 6	80	0.0 0.0 0.0	36.5	5.7	<u>(</u>	† "	 	5.0
1987	871	39	ž Ž		24	61	41.8	39.0	- 1	₹ Z) ()	-	2.7
1989	902	28	₹		. 4	58	41.2	37.1	2.4	₹	0.3	1.7	2.4
1991	686	72	Ϋ́	13	4	72	42.7	38.7	2.8	Ϋ́	0.5	1.6	2.8
1993	894	89	¥	13	32	77	45.5	40.1	4.0	Ϋ́	9.0	4.1	3.5
1995	1,020	86	Ϋ́	21	22	89	47.2	42.9	4.1	Ϋ́	6:0	2.4	2.9
FFRDCs	!	ı	:	;		,		,	,	,	;	,	
1981	49	2	Ξ	Ϋ́	-	က	37.1	29.3	3.0	9.9	Υ	9.0	1 .8
1983	48	13	12	Ϋ́	2	2	42.3	30.8	8.3	7.7	Υ V	3.2	1.3
1985	20	2	7	Ϋ́	7	2	45.5	37.3	3.7	5.2	Ϋ́	1.5	3.7
1987	28	2	7	Ϋ́	2	-	57.1	51.8	1.8	6.3	ΑN	1.8	6.0
1989	20	o	7	Ϋ́	-	-	45.2	40.3	7.3	5.6	ΑN	0.8	0.8
1991	45	က	13	Ϋ́	2	ო	58.1	48.4	3.2	14.0	ΑN	2.2	3.2
1993	29	9	13	Ϋ́	2	4	65.5	52.2	5.3	11.5	ΑN	4.4	3.5
1995	69	80	21	Ϋ́	7	7	61.8	52.7	6.1	16.0	Υ V	1.5	1.5
Nonprofits													
1981	221	9	38	7	Ϋ́	20	36.2	30.4	8.0	5.2	0.3	Ϋ́	2.8
1983	247	13	45	2	Ā	18	44.5	37.8	2.0	6.9	0.8	Ϋ́	2.8
1985	194	7	26	2	Ϋ́	17	41.1	35.3	1.3	4.7	0.4	Ϋ́	3.1
1987	182	တ	24	2	Ϋ́	10	44.8	39.0	1.9	5.1	0.4	Ϋ́	2.1
1989	232	7	4	-	Ϋ́	12	43.2	37.4	1.8	9.9	0.2	Ϋ́	1.9
1991	225	13	41	2	Ā	23	42.5	36.6	2.1	6.7	0.3	Ϋ́	3.7
1993	213	18	32	2	Ϋ́	24	46.4	37.8	3.2	2.7	6.0	Ϋ́	4.3
1995	254	23	22	2	Ϋ́	18	50.1	43.1	3.9	9.7	0.3	Ϋ́	3.1
Other													
1981	262	13	99	0	20	Ϋ́	51.9	41.3	2.1	10.4	0.0	3.2	ΑN
1983	213	18	69	2	18	Ϋ́	54.6	41.1	3.5	13.3	0.4	3.5	Ϋ́
1985	202	21	64	2	17	Ϋ́	55.1	40.6	4.2	12.9	1.0	3.4	Ϋ́
1987	163	13	61	-	10	Ϋ́	54.9	43.0	3.4	16.1	0.3	2.6	Ϋ́
1989	242	21	28	-	12	ΑN	61.5	49.8	4.3	11.9	0.2	2.5	Ϋ́
1991	234	21	72	က	23	Υ V	58.4	46.2	4.1	14.2	9.0	4.5	Ϋ́
1993	252	19	77	4	24	ΑN	65.7	6.05	3.8	15.6	0.8	4.8	Ϋ́
1995	210	28	99	2	18	Ϋ́	63.3	52.1	6.9	16.9	0.5	4.5	₹ Z
2 - 0 0													

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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

'													
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All sectors	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
						Chemistry							
Academia													
1981	Ϋ́	269	188	194	101	23	8.9	ΑN	3.2	2.2	2.3	1.2	0.3
1983	Ϋ́	328	202	182	06	19	9.2	ΑN	3.9	2.4	2.1		0.2
1985	Ϋ́	365	227	183	74	29	9.3	ΑN	4.1	2.5	2.0	0.8	0.3
1987	Ϋ́	468	225	255	71	25	10.6	ΑN	5.0	2.4	2.7	0.8	0.3
1989	Ϋ́	518	226	293	92	17	10.7	ΑN	5.1	2.2	2.9	0.8	0.2
1991	Ϋ́	622	260	298	123	29	11.9	ΑN	5.8	2.4	2.8	- -	0.5
1993	ΑN	929	263	332	111	38	11.7	AN	5.9	2.3	3.0	1.0	0.3
1995	Ϋ́	717	311	409	150	40	13.8	ΑN	6.5	2.8	3.7	4.1	0.4
Industry													
1981	569	Ϋ́	24	တ	12	7	14.9	13.5	Ϋ́	1.2	0.5	9.0	0.4
1983	328	Ϋ́	52	27	=	6	18.3	15.3	Ϋ́	2.4	1.3	0.5	0.4
1985	365	Ϋ́	37	20	23	6	18.9	16.4	Ϋ́	1.7	0.9	1.0	0.4
1987	468	Ϋ́	29	32	19	7	23.1	19.8	Ϋ́	2.5	4.1	0.8	0.3
1989	518	Ϋ́	78	4	13	=	26.1	21.9	Ϋ́	3.3	1.7	0.5	0.5
1991	622	Ϋ́	91	42	56	24	27.8	23.8	Ϋ́	3.5	1.6	1.0	0.9
1993	656	Ϋ́	91	22	29	17	30.0	25.5	Ϋ́	3.5	2.2	1:	0.7
1995	717	Ϋ́	66	48	13	7	33.0	29.0	Ϋ́	4.0	1.9	0.5	0.4
Federal Government													
1981	188	24	Ϋ́	2	10	က	25.8	22.9	2.9	Ϋ́	0.2	1.2	0.4
1983	202	52	Ϋ́	10	13	2	29.1	22.8	5.9	Ą	1.1	1.5	9.0
1985	227	37	Ϋ́	တ	17	က	27.9	23.4	3.8	Ϋ́	6.0	1.8	0.3
1987	225	29	Ϋ́	2	12	2	32.5	25.6	6.7	Ϋ́	9.0	4.1	9.0
1989	226	78	Ϋ́	14	13	က	35.1	25.6	8.8	Ϋ́	1.6	1.5	0.3
1991	260	91	Ϋ́	25	20	20	38.1	27.8	9.7	Ϋ́	2.7	2.1	2.1
1993	263	91	Ϋ́	15	28	13	40.4	29.8	10.3	Ϋ́Z	1.7	3.2	1.5
1995	311	66	Ϋ́	33	10	9	40.6	32.1	10.2	Ϋ́	3.4	1.0	9.0
FFRDCs													
1981	194	6	2	Α	0	_	37.1	34.5	1.6	0.4	Ϋ́	0.0	0.2
1983	182	27	10	Ϋ́	က	0	39.3	32.5	4.8	1.8	Ϋ́	0.5	0.0
1985	183	20	o	ΑN	2	0	39.6	33.2	3.6	1.6	Ϋ́	0.4	0.0
1987	255	32	2	A	က	-	46.0	41.3	5.2	0.8	Ϋ́	0.5	0.2
1989	293	4	14	ΑN	-	0	47.6	42.2	5.9	2.0	Ϋ́	0.1	0.0
1991	298	42	25	ΑN	တ	2	49.6	42.2	5.9	3.5	Ϋ́	1.3	0.3
1993	332	22	15	A	က	က	54.2	48.6	8.3	2.2	Ϋ́	0.4	0.4
1995	409	48	33	Ϋ́	9	9	52.5	48.6	2.7	3.9	N A	0.7	0.7

Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

Sector													
	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All sectors	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
Nome to fit													
Nonpronts	3	,	1	•	3	,	1	0	Ċ	o o	1	-	Ó
1981		72	0	4	Ϋ́	_	37.0	32.0	3.8	3.2	5.7	Z Z	0.3
1983	06	7	13	က	Ϋ́	_	38.7	31.9	3.9	4.6	1.1	Ϋ́	4.0
1985	74	23	17	2	Ϋ́Z	-	36.1	26.0	8.1	0.9	0.7	Ϋ́	9.4
1987	71	19	12	က	Ϋ́	2	37.1	28.3	7.6	4.8	1.2	Ϋ́	0.8
1989	92	13	13	-	Ϋ́Z	0	37.7	29.2	2.0	5.0	0.4	Ϋ́	0.0
1991	123	26	20	6	Ϋ́Z	22	45.0	35.2	7.4	5.7	2.6	Ą	4.1
1993	1 -	000	80	o er	٥	9 4	40.8	8 60	α	7.5	α	ΔN	-
1006	- C	7 7	0 7	ט ע	<u> </u>	† τ	, 4 , 6	20.0	- с Э п			<u> </u>	- c
	001	2	2	0	Į Z	_	43.2	9. 9.	o.:0	7.7	o: -	1	o.
Other													
1981	23	7	က	-	-	Ϋ́	34.9	26.7	8.1	3.5	1.2	1.2	Ϋ́
1983	19	တ	2	0	-	Ϋ́	28.3	20.7	9.8	5.4	0.0	1.1	Ϋ́
1985	29	6	က	0	-	Ϋ́	39.6	31.9	6.6	3.3	0.0	1.1	Ϋ́
1987	25	7	2	-	2	Ϋ́	51.4	34.7	9.7	6.9	4.1	2.8	∢ Z
1989	17	1	က	0	0	Ϋ́	41.1	23.3	15.1	4.1	0.0	0.0	Ž
1991	5.9	24	00	0	ı.c	Ā	56.3	41.0	16.7	13.9	1 4	3.5	ΑN
1993	38	17	13	m	4	Ą	55.0	34.2	15.3	11.7	2.7	98	₹ Z
1995	9 Q	=======================================	. w) (C		ΔN	67.5	50.0	20 00	7.5	7 7	. .	ΔN
	P P	-			-	<u> </u>	5.	0.00	2.0	5.	5.	5	5
						Physics							
Academia													
1981	Ϋ́	208	298	856	88	80	17.5	ΑN	5.3	3.1	9.0	0.9	0.1
1983	Ą	603	340	866	126	28	19.8	ΑN	6.2	3.5	10.2	1.3	0.3
1985	Ą	806	385	1,153	116	27	19.8	ΑN	8.9	3.3	9.8	1.0	0.2
1987	Ϋ́	878	400	1,301	124	22	20.4	Ϋ́	7.1	3.2	10.5	1.0	0.2
1989	¥	1,047	490	1.327	157	25	20.2	Ϋ́	7.5	3.5	9.6		0.2
1991	Ϋ́	1,229	562	1,442	203	42	21.2	Ϋ́	8.3	8,8	9.7	4.	0.3
1993	₹ Z	1.180	681	1.576	178	29	22.1	Ϋ́Z	6.7	4.5	10.5	1.2	4.0
1995	₹ Z	1,189	719	1,762	204	44	21.5	Ϋ́Z	7.3	4.4	10.8	1.2	0.3
Industry													
1981	508	Ϋ́	77	75	9	က	24.2	19.9	Ą	3.0	2.9	0.2	0.1
1983	603	Ϋ́	66	131	19	4	29.2	23.0	ΑN	3.8	5.0	0.7	0.5
1985	806	Ν	120	155	22	12	28.7	23.0	Ϋ́	3.4	4.4	9.0	0.3
1987	878	Ϋ́	114	177	23	12	30.8	25.1	Ą	3.3	5.1	0.7	0.3
1989	1,047	Ϋ́	187	197	27	7	33.9	27.6	Ϋ́	4.9	5.2	0.7	0.2
1991	1,229	Ϋ́	234	259	38	17	38.7	31.0	Ą	5.9	6.5	1.0	9.0
1993	1,180	Ϋ́	247	245	35	26	44.9	35.8	Ϋ́	7.5	7.4	1:1	0.8
1995	1,189	ΑN	254	338	24	18	51.4	39.9	Ϋ́	8.5	11.3	0.8	9.0

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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of r	nultisector	Number of multisector articles coauthored by:	thored by:				Percent of al	ll articles co	Percent of all articles coauthored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
Federal Government													
1981	298	77	¥	54	7	S)	35.9	27.5	7.1	Ϋ́	5.0	9.0	0.5
1983	340	66	Ϋ́	63	4	10	42.1	32.6	9.5	Ϋ́	6.0	0.4	1.0
1985	385	120	Ϋ́	48	4	2	39.5	30.6	9.5	Ϋ́	3.8	0.3	0.4
1987	400	114	Ϋ́	63	9	1	43.6	33.6	9.6	Ϋ́	5.3	0.5	6.0
1989	490	187	Ą	82	12	-	46.4	35.3	13.5	Ϋ́	5.9	6.0	0.1
1991	562	234	¥	88	27	6	51.3	37.3	15.5	Ϋ́	5.9	1.8	9.0
1993	681	247	Ϋ́	92	24	4	55.6	43.3	15.7	ΑN	5.8	1.5	6.0
1995	719	254	Ϋ́	118	22	9	54.7	42.4	15.0	Α	7.0	1.3	0.4
FFRDCs													
1981	856	75	54	Ϋ́	15	0	40.2	35.4	3.1	2.2	Ϋ́	9.0	0.0
1983	866	131	63	Ϋ́	10	ო	45.3	39.6	5.2	2.5	Ϋ́	0.4	0.1
1985	1,153	155	48	Ϋ́	17	ო	44.0	38.2	5.1	1.6	Ϋ́	9.0	0.1
1987	1,301	177	63	Ϋ́	24	ო	48.4	42.2	5.7	2.0	Ϋ́	0.8	0.1
1989	1,327	197	82	Ϋ́	19	2	47.9	40.9	6.1	2.5	Ϋ́	9.0	0.2
1991	1,442	259	88	Ϋ́	28	∞	51.2	44.3	8.0	2.7	Ϋ́	6.0	0.2
1993	1,576	245	92	Ϋ́	31	∞	57.7	50.2	7.8	2.9	Ϋ́	1.0	0.3
1995	1,762	338	118	Ϋ́	31	13	53.5	45.6	8.8	3.1	Ϋ́	0.8	0.3
Nonprofits													
1981	88	9	7	Ξ	Ϋ́	0	44.0	35.6	2.4	2.8	4.4	Ϋ́	0.0
1983	126	19	4	10	Ā	0	47.9	43.2	6.5	4.1	3.4	Ϋ́	0.0
1985	116	22	4	17	¥	က	41.9	34.9	9.9	1.2	5.1	ΑN	6.0
1987	124	23	9	24	Ą	0	44.7	37.2	6.9	1.8	7.2	ΑĀ	0.0
1989	157	27	12	19	Ϋ́	0	49.7	42.2	7.3	3.2	5.1	Ϋ́	0.0
1991	203	38	27	28	Ā	7	60.2	48.7	9.1	6.5	6.7	Ϋ́	0.5
1993	178	35	24	31	Ϋ́	-	57.8	47.2	9.3	6.4	8.2	Ϋ́	0.3
1995	204	24	22	31	Ϋ́	2	62.3	55.3	6.5	0.9	8.4	Ϋ́	0.5
Other													
1981	∞	ო	2	4	0	ΑN	38.5	20.5	7.7	12.8	10.3	0.0	Ϋ́Z
1983	28	4	10	က	0	ΑN	47.7	32.6	16.3	11.6	3.5	0.0	Ϋ́
1985	27	12	2	က	က	ΑN	42.9	29.7	13.2	5.5	3.3	3.3	Ϋ́
1987	22	12	1	က	0	ΑN	56.3	31.0	16.9	15.5	4.2	0.0	ΑN
1989	25	7	-	2	0	ΑN	49.3	37.3	10.4	1.5	7.5	0.0	۷Z
1991	42	17	ග	80	2	ΑN	58.4	41.6	16.8	8.9	7.9	2.0	Ϋ́
1993	29	56	4	80	-	ΑN	63.6	44.7	19.7	10.6	6.1	8.0	ΑN
1995	44	18	9	13	2	ΑN	68.5	49.4	20.2	6.7	14.6	2.2	Ν Α

Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of r	nultisector	Number of multisector articles coauthored by:	thored by:				Percent of a	l articles co	Percent of all articles coauthored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
					Earth a	Earth and space sciences	iences						
Academia													
1981	Ϋ́	207	260	357	174	22	21.5	Ą	3.7	10.0	6.4	3.1	1.0
1983	Ϋ́	222	530	320	187	81	22.2	Ą	4.2	10.0	0.9	3.5	1.5
1985	ΑN	286	604	363	217	86	23.4	ΑΝ	4.9	10.3	6.2	3.7	1.7
1987	Ϋ́	311	645	411	250	115	24.6	ΑΝ	5.0	10.5	6.7	4.1	1.9
1989	Ϋ́	336	628	401	346	113	24.9	Ą	5.4	10.1	6.5	5.6	1.8
1991	Ϋ́	351	764	474	405	126	27.3	Ą	5.3	11.5	7.1	6.1	1.9
1993	Ϋ́	380	892	523	416	129	27.0	Ą	5.2	12.2	7.2	5.7	1.8
1995	Ϋ́	467	1,108	652	512	158	29.4	N	2.7	13.5	7.9	6.2	1.9
Industry													
1981	207	Ϋ́	127	34	17	=	51.0	34.2	Ϋ́	21.0	5.6	2.8	1.8
1983	222	¥	139	31	18	20	53.2	33.4	Ϋ́	20.9	4.7	2.7	3.0
1985	286	Ϋ́	173	36	35	33	52.2	32.7	Ϋ́	19.8	4.1	4.0	3.8
1987	311	₹	198	89	32	38	55.7	34.3	Ϋ́	21.8	7.5	3.5	4.2
1989	336	Ϋ́	203	55	46	52	57.7	37.5	Ϋ́	22.7	6.1	5.1	5.8
1991	351	₹	198	53	45	37	55.4	37.1	Ϋ́	20.9	5.6	4.8	3.9
1993	380	Ϋ́	255	61	47	44	65.2	42.4	ΑN	28.4	8.9	5.2	4.9
1995	467	Ā	296	110	64	41	68.4	44.7	Ϋ́	28.4	10.5	6.1	3.9
Federal Government													
1981	260	127	¥	88	46	19	44.1	34.7	7.9	Ϋ́	5.5	2.9	1.2
1983	530	139	Ϋ́	78	42	21	44.9	34.5	0.6	Ϋ́	5.1	2.7	1.4
1985	604	173	Ϋ́	88	29	24	47.6	35.2	10.1	Ϋ́	5.2	3.9	1.4
1987	645	198	Ϋ́	105	71	40	50.9	37.0	11.4	Ϋ́	0.9	4.1	2.3
1989	628	203	Ϋ́	132	82	41	51.9	37.4	12.1	Ϋ́	6.7	4.9	2.4
1991	764	198	Ϋ́	129	100	38	53.8	41.6	10.8	Ϋ́	7.0	5.4	2.1
1993	892	255	Ϋ́	157	110	20	57.8	44.9	12.8	Ϋ́	6.7	5.5	2.5
1995	1,108	296	Ž	207	148	48	62.3	48.5	13.0	Ϋ́	9.1	6.5	2.1
FFRDCs		,		;					,			,	
1981	357	34	88	¥ X	19	ဖ	50.4	42.5	4.0	10.5	Υ Υ	2.3	0.7
1983	320	31	78	Ϋ́	28	15	49.6	40.2	3.9	8.6	∀	3.5	1.9
1985	363	36	83	Ϋ́	33	ო	52.3	43.2	4.3	10.6	₹ Z	3.9	4.0
1987	411	89	105	Ϋ́	39	∞	55.3	43.2	7.2	11.0	¥ Z	4.1	0.8
1989	401	22	132	Ϋ́	9/	о	9.75	44.2	6.1	14.5	Ϋ́	8.4	1.0
1991	474	53	129	Ϋ́	65	7	59.3	47.9	5.4	13.0	Ϋ́	9.9	0.7
1993	523	61	157	Ϋ́	74	16	8.09	50.4	5.9	15.1	₹ Z	7.1	1.5
1995	652	110	207	Ϋ́	86	21	60.1	48.0	8.1	15.3	Ą Z	7.2	1.5

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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of	multisector	Number of multisector articles coauthored by:	thored by:				Percent of a	Percent of all articles coauthored by:	authored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
Nonprofits													
1981	174	17	46	19	Ϋ́	ო	46.3	38.6	3.8	10.2	4.2	ΑN	0.7
1983	187	18	42	28	Ϋ́	9	46.0	37.6	3.6	8.4	5.6	ΑN	1.2
1985	217	35	29	33	Ϋ́	9	48.3	37.9	6.1	11.7	5.8	ΑN	1.0
1987	250	32	71	39	Ϋ́	2	57.6	45.5	5.8	12.9	7.1	Ϋ́	6.0
1989	346	46	82	9/	Ϋ́	19	57.3	45.3	0.9	10.7	6.6	ΑN	2.5
1991	405	45	100	92	Ϋ́	17	56.9	47.1	5.2	11.6	7.6	Ϋ́	2.0
1993	416	47	110	74	Ϋ́	21	0.09	48.8	5.5	12.9	8.7	ΑN	2.5
1995	512	64	148	86	Ϋ́	12	63.7	52.5	9.9	15.2	10.0	ΑN	1.2
Other													
1981	22	=======================================	19	9	က	Ϋ́	51.0	39.3	7.6	13.1	4.1	2.1	N A
1983	81	20	21	15	9	ΑN	62.2	47.1	11.6	12.2	8.7	3.5	N A
1985	86	33	24	က	9	ΑN	53.2	37.3	12.5	9.1	- -	2.3	Ϋ́
1987	115	38	40	∞	2	Ϋ́	62.3	43.4	14.3	15.1	3.0	1.9	N A
1989	113	52	41	တ	19	Ν Α	64.1	39.4	18.1	14.3	3.1	9.9	AN
1991	126	37	38	7	17	Ϋ́	58.2	42.1	12.4	12.7	2.3	5.7	N A
1993	129	44	20	16	21	Ν Α	65.8	44.2	15.1	17.1	5.5	7.2	AN
1995	158	41	48	21	12	ΑN	70.0	52.7	13.7	16.0	7.0	4.0	ΝΑ
					Engineering	ring and tec	and technology						
Academia													
1981	Ϋ́Z	746	260	259	29	69	20.1	Υ	11.5	4.0	4.0	1.0	1.1
1983	Ϋ́	811	311	275	29	62	20.3	ΑN	11.6	4.5	3.9	0.8	6.0
1985	Ϋ́	645	273	256	51	36	18.4	Ϋ́	10.2	4.3	4.0	0.8	9.0
1987	Ϋ́	617	283	241	59	48	18.5	Ϋ́	10.0	4.6	3.9	1.0	0.8
1989	Ϋ́	644	277	278	61	30	18.1	Ϋ́	9.7	4.2	4.2	6.0	0.5
1991	Ą	810	333	282	65	46	20.1	Υ V	4.11	4.7	4.0	6.0	9.0
1993	Ą	818	382	297	89	80	20.4	Υ V	11.0	5.2	4.0	6.0	- -
1995	Ą	896	443	321	99	46	21.3	N A	12.4	2.7	4.1	8.0	9.0
Industry													
1981	746	Ϋ́	159	88	4	53	20.7	15.6	Ϋ́	3.3	1.9	6.0	-:
1983	811	Ϋ́	188	118	39	20	21.8	16.0	Ą V	3.7	2.3	0.8	1.0
1985	645	Ą	123	112	29	32	24.3	17.9	Ϋ́	3.4	3.1	1.6	6.0
1987	617	Ą	121	64	31	16	29.0	23.4	Ϋ́	4.6	2.4	1.2	9.0
1989	644	Ą	122	73	35	18	29.7	23.3	Ϋ́	4.4	2.6	1.3	0.7
1991	810	Ą	137	80	36	26	32.3	26.3	Ϋ́	4.4	2.6	1.2	8.0
1993	818	Ą	179	88	37	48	36.7	28.2	Ϋ́	6.2	3.1	1.3	1.7
1995	896	Ϋ́	231	123	41	35	40.7	32.2	Ϋ́Z	7.7	4.1	4.1	1.2
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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of multisector		articles coauthored by:	thored by:				Percent of all articles coauthored by:	l articles co	authored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
Federal Government													
1981	260	159	Ϋ́	33	14	21	34.1	20.7	12.7	ΑN	2.6	1.1	1.7
1983	311	188	Ϋ́Z	42	4	12	36.6	22.9	13.8	ΑN	3.1	1.0	6.0
1985	273	123	Ϋ́	39	24	10	37.9	25.1	11.3	ΑN	3.6	2.2	6.0
1987	283	121	¥	27	10	7	45.2	32.6	14.0	Ä	3.1	1.2	0.8
1989	277	122	¥	35	10	2	43.9	30.3	13.4	Ä	3.8	1.1	0.5
1991	333	137	Ą	14	12	9	44.4	33.4	13.8	¥	1.4	1.2	9.0
1993	382	179	Ą	32	29	17	52.0	35.6	16.7	Α	3.0	2.7	1.6
1995	443	231	Ϋ́	44	19	6	53.8	38.5	20.1	Υ V	3.8	1.6	0.8
1981	259	68	33	ΔN	g	cr.	24.6	0 81	0	6	AN	40	0.0
1983	275	2 5	4 6	ζ Δ	o (c	ט ער	0.00	2. 6.	2 C	i α	ΔZ		i e.
1985	256	112	3 6	Z Z	000) 4	29.4	18.2	0.80	8	₹ Z	9.0	0.3
1987	241	64	27	₹ Z	7	·	28.8	21.1	5.6	2.4	₹ Z	9.0	0.5
1989	278	73	35	Ϋ́	10	က	39.8	28.7	7.5	3.6	Ϋ́	1.0	0.3
1991	282	80	14	۷Z	+	2	44.1	31.9	9.0	1.6	Ϋ́	1.2	0.2
1993	297	88	32	۷Z	13	2	46.1	33.4	10.0	3.6	Ϋ́	1.5	9.0
1995	321	123	44	Ϋ́Z	22	7	47.5	33.0	12.6	4.5	Ϋ́	2.3	0.7
Nonprofits													
1981	29	41	14	9	AN	9	32.2	19.3	11.8	4.0	1.7	Ϋ́	1.7
1983	29	39	14	9	AN	2	32.2	17.8	11.7	4.2	1.8	Ϋ́	1.5
1985	51	29	24	80	AN	က	42.0	19.0	21.9	8.9	3.0	Ϋ́	1.1
1987	29	31	10	7	ΑN	0	40.9	28.4	14.9	4.8	3.4	Ϋ́	0.0
1989	61	35	10	10	ΑN	-	42.5	26.2	15.0	4.3	4.3	Ϋ́	0.4
1991	99	36	12	=======================================	ΑN	7	46.8	29.5	16.4	5.5	5.0	Ϋ́	6.0
1993	89	37	29	13	N A	9	53.8	28.6	15.5	12.2	5.5	Ϋ́	2.5
1995	99	41	19	22	Υ V	4	53.3	30.8	19.2	8.9	10.3	Ϋ́	1.9
Other													
1981	69	53	21	ო	9	A A	41.2	22.9	17.6	7.0	1.0	2.0	Υ V
1983	62	20	12	ည	2	Υ V	52.0	27.6	22.2	5.3	2.2	2.2	Ϋ́
1985	36	32	10	4	က	A A	51.4	25.0	22.2	6.9	2.8	2.1	Ϋ́
1987	48	16	7	9	0	A A	60.2	46.6	15.5	8.9	5.8	0.0	Ϋ́
1989	30	18	2	ო	-	ΑN	50.5	31.6	18.9	5.3	3.2	1.1	Ϋ́
1991	46	26	9	7	7	A A	46.6	31.1	17.6	4.1	1.4	4.	Υ V
1993	80	48	17	ည	9	Υ V	62.0	37.6	22.5	8.0	2.3	2.8	Ϋ́
1995	46	35	6	7	4	ΑN	61.9	33.1	25.2	6.5	5.0	2.9	Ϋ́

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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of r	multisector a	Number of multisector articles coauthored by:	hored by:				Percent of all articles coauthored by:	l articles co	authored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
					Ž	Mathematics							
Academia													
1981	₹	88	36	36	45	6	5.4	Ϋ́	2.3	6.0	6.0	1:1	0.2
1983	Ą	100	42	25	55	9	0.9	Ϋ́	2.7	 -	0.7	1.5	0.2
1985	Ą	105	22	35	38	2	6.4	Ϋ́	2.8	1.5	0.9	1.0	0.1
1987	Ϋ́	80	35	38	42	-	6.3	ΑN	2.7	1.2	1.3	4.1	0.0
1989	Ą	26	36	30	36	7	5.1	Ϋ́	2.5	0.9	0.8	6.0	0.2
1991	Ϋ́Z	92	43	33	38	12	0.9	ΑN	2.3	1.3	1.0	1.2	0.4
1993	Ą	114	53	34	44	6	7.2	Ϋ́	3.4	1.6	1.0	1.3	0.3
1995	Ϋ́	62	37	26	47	10	6.2	Ϋ́Z	2.6	1.2	6.0	1.5	0.3
Industry													
1981	88	ΑN	ო	0	-	0	44.2	42.8	Ϋ́	4.1	0.0	0.5	0.0
1983	100	ΑN	2	9	2	-	45.1	42.6	Ϋ́	6.0	2.6	6.0	0.4
1985	105	Ϋ́	2	7	0	0	44.5	42.9	Ϋ́	2.0	0.8	0.0	0.0
1987	80	Ϋ́	6	ო	2	0	47.4	42.1	Ϋ́	4.7	1.6	5.6	0.0
1989	26	Ϋ́	9	7	က	8	54.2	51.1	Ϋ́	3.2	- -	1.6	1.1
1991	92	Ϋ́	9	-	-	-	52.3	49.0	Ϋ́	3.9	9.0	9.0	9.0
1993	114	Ϋ́	6	7	2	8	61.2	29.7	Ϋ́	4.5	1.0	2.5	1.0
1995	79	ΑN	ო	-	4	-	58.3	56.8	Ϋ́	2.2	0.7	2.9	0.7
Federal Government													
1981	36	က	ΑN	_	-	0	35.1	32.4	2.7	Ϋ́	6.0	6.0	0.0
1983	42	2	ΑN	0	-	0	50.0	47.7	2.3	¥	0.0	1.1	0.0
1985	22	2	Ν	0	0	-	41.8	39.0	3.4	Ϋ́	0.0	0.0	0.7
1987	35	o	ΝΑ	0	က	0	42.1	36.8	9.5	Ϋ́	0.0	3.2	0.0
1989	36	9	ΑN	-	က	0	45.7	39.1	6.5	¥	- -	3.3	0.0
1991	43	9	A A	-	7	-	53.8	46.2	6.5	Ϋ́	1.1	2.2	1.1
1993	53	6	A A	0	က	7	54.9	46.9	8.0	Ϋ́	0.0	2.7	1.8
1995	37	က	Y Y	-	2	0	51.4	50.0	4.1	Ϋ́	4.	2.7	0.0
FFRDCs													
1981	36	0	-	N A	0	-	49.4	46.8	0.0	1.3	Ϋ́	0.0	1.3
1983	25	9	0	N A	0	0	44.8	37.3	0.6	0.0	Ϋ́	0.0	0.0
1985	35	7	0	Ϋ́	-	0	56.3	54.7	3.1	0.0	Ϋ́	1.6	0.0
1987	38	က	0	Ϋ́	-	0	54.4	48.1	3.8	0.0	Ϋ́	1.3	0.0
1989	30	7	-	N A	0	0	48.1	39.0	2.6	1.3	¥	0.0	0.0
1991	33	-	-	Ϋ́	-	0	52.2	47.8	1.4	4.1	Ϋ́	4.1	0.0
1993	34	7	0	N A	0	0	51.5	50.0	2.9	0.0	Ϋ́	0.0	0.0
1995	26	-	-	Ϋ́	0	0	57.4	55.3	2.1	2.1	₹ Z	0.0	0.0

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Appendix table 5-46. Coauthorship of U.S. scientific and technical articles across sectors, by article field: 1981-95

		Number of	Number of multisector ar	articles coauthored by:	thored by:				Percent of all articles coauthored by:	articles coa	authored by:		
Sector	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others	All	Academia	Industry	Federal Govt.	FFRDCs	Nonprofits	All others
Nonprofits													
1981	45	-	-	-	Ϋ́	-	50.5	49.5	1.1	1.1	1.1	ĄZ	1.1
1983	55	2	-	0	Ϋ́	0	56.1	56.1	2.0	1.0	0.0	Ϋ́	0.0
1985	38	0	0	-	Ϋ́	0	43.3	42.2	0.0	0.0	1.1	Ϋ́	0.0
1987	42	2	ო	-	Ϋ́	0	47.8	45.7	5.4	3.3	1.1	Ϋ́Z	0.0
1989	36	ო	ო	0	Ϋ́	2	59.1	54.5	4.5	4.5	0.0	Ϋ́	3.0
1991	38	-	2	_	Ϋ́	0	51.3	47.5	1.3	2.5	1.3	Ϋ́	0.0
1993	44	2	ო	0	Ϋ́	0	58.2	55.7	6.3	3.8	0.0	Ϋ́Z	0.0
1995	47	4	0	0	Ϋ́	-	65.3	62.7	5.3	2.7	0.0	Ϋ́	1.3
Other													
1981	တ	0	0	0	-	Ϋ́	58.8	52.9	0.0	0.0	0.0	5.9	ΑN
1983	9	-	0	0	0	Ϋ́	77.8	66.7	11.1	0.0	0.0	0.0	ΑN
1985	2	0	-	0	0	Ϋ́	35.7	35.7	0.0	7.1	0.0	0.0	ΑN
1987	-	0	0	0	0	Ϋ́	16.7	16.7	0.0	0.0	0.0	0.0	ΑN
1989	7	7	0	0	7	Ϋ́	47.4	36.8	10.5	0.0	0.0	10.5	ΑN
1991	12	-	-	0	0	Ϋ́	0.09	0.09	5.0	5.0	0.0	0.0	ΑN
1993	တ	7	7	0	0	Ϋ́	73.3	0.09	13.3	13.3	0.0	0.0	ΑN
1995	10	-	0	0	-	ΑN	80.0	2.99	6.7	0.0	0.0	6.7	٩

FFRDC = federally funded research and development center; NA = not available

NOTES: Cross-sector percentages add to more than percentage coauthored with all sectors because of papers with authors in more than two sectors. Coauthored articles are counted in each collaborating sector. Details may not add to totals because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

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Appendix table 5-47. Distributions in U.S. scientific and technical articles to other U.S. scientific and technical articles, by sector and field: 1990 and 1995

Sector Academic	Citina													
Academic	year	All sectors	Academia	Industry	Federal Govt.	FFRDCs	Non- profits	Others	Academia	Industry	Federal Govt.	FFRDCs	Non- profits	Others
AcademicIndustry					All natural	science	and engineering fields	ring fields						
Industry	1990	440,334	335,353	25,252	34,940	6,440	33,321	5,028	9/	9	8	-	8	-
Industry	1995	443,191	341,017	26,165	30,500	6,126	34,908	4,474	77	9	7	-	œ	-
	1990	41,586	19,270	15,353	3,369	750	2,352	491	46	37	80	2	9	-
	1995	39,085	19,628	12,744	2,929	551	2,827	407	20	33	7	-	7	-
Federal Government	1990	54,570	28,157	3,439	17,462	683	4,030	800	52	9	32	-	7	-
	1995	49,271	26,717	3,139	14,409	673	3,638	693	54	9	29	-	7	-
FFRDCs	1990	10,114	4,955	1,116	547	3,203	269	24	49	=	2	32	က	0
	1995	10,658	5,766	822	771	2,947	313	38	54	∞	7	28	က	0
Nonprofits	1990	50,298	29,677	2,523	4.533	338	12,285	941	29	2	o	-	24	0
-	1995	52,378	31,645	2,738	3,792	280	13,110	813	09	2	7	-	25	0
All other	1990	7,800	4,605	406	934	65	825	965	29	2	12	-	Ξ	12
	1995	6,814	4,111	410	757	35	787	714	09	9	Ξ	-	12	10
						Clinical n	medicine							
Academic	1990	159.444	116.645	5.212	15.584	234	18.350	3,419	73	33	10	0	12	2
	1995	151,621	110,581	7,347	12,834	202	17,720	2,937	73	2	∞	0	12	8
Industry	1990	11,098	5,588	2,866	1,223	15	1,107	297	20	26	7	0	10	က
	1995	12,630	6,285	3,729	1,051	15	1,339	211	20	30	80	0	Ξ	2
Federal Government	1990	22,246	11,749	917	6,767	34	2,243	537	53	4	30	0	9	7
	1995	18,819	10,241	977	5,195	33	1,938	437	54	2	28	0	1	2
FFRDCs	1990	495	288	22	52	73	52	7	58	4	7	15	Ξ	-
	1995	457	281	22	40	22	36	4	19	2	တ	16	œ	-
Nonprofits	1990	28,340	16,566	927	2,667	36	7,411	733	28	က	6	0	56	က
	1995	28,254	16,465	1,274	2,233	28	2,609	645	58	2	80	0	27	7
All other	1990	4,945	2,956	179	265	2	989	574	09	4	12	0	13	12
	1995	4,222	2,549	182	457	5	591	442	09	4	7	0	14	10
						Biomedical research	Iresearch							
Academic	1990	155,167	119,366	8,665	12,384	663	12,661	1,097	27	9	8	-	8	1
	1995	164,284	129,210	8,782	10,201	896	14,225	868	29	2	9	-	6	_
Industry	1990	11,400	5,970	3,066	1,151	94	1,002	118	52	27	10	-	6	-
	1995	13,357	7,435	3,504	957	85	1,264	112	26	26	7	-	6	-
Federal Government	1990	18,755	10,049	1,328	5,581	136	1,525	136	54	7	30	-	∞	-
	1995	16,847	9,863	1,052	4,333	111	1,372	116	29	9	26	-	∞	-
FFRDCs	1990	1,336	784	105	87	284	73	7	29	80	7	21	2	0
	1995	1,552	266	106	109	248	87	9	64	7	7	16	9	0
Nonprofits	1990	17,787	10,619	1,295	1,566	106	4,026	175	09	7	6	-	23	-
	1995	19,663	12,448	1,244	1,234	92	4,513	129	63	9	9	0	23	-
All other	1990	1,800	1,055	126	202	50	149	249	29	7	Ξ	-	ω	4
	1995	1,743	1,086	132	188	Ξ	159	166	62	∞	Ξ	-	တ	10

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Appendix table 5-47. Distributions in U.S. scientific and technical articles to other U.S. scientific and technical articles, by sector and field: 1990 and 1995

				Numb	Number of citations to:	ns to:				Perce	Percent of citations to:	ons to:		
Citing sector	Citing year	All	Academia	Industry	Federal Govt.	FFRDCs	Non- profits	Others	Academia	Industry	Federal Govt.	FFRDCs	Non- profits	Others
						Biology	gy							
Academic	1990	24,010	20,558	526	2,046	4 i	593	244	98	5	o (0 (0.0	- ,
	1995	19,740	16,481	532	1,849	, 1	5/8 27	253		. t	ກຸ	> c	n c	- т
madally	1995	866 866	51.5	192	115	- m	27	° C	8 6	- 6	<u> </u>	o C	ე თ	
Federal Government	1990	4.034	2.014	95	1.789	വ	73	29	20	~	4 4	0	0 0	
	1995	3,620	1,843	06	1,526	6	92	61	51	2	42	0	က	2
FFRDCs	1990	65	47	2	2	6	2	0	72	က	80	14	က	0
	1995	120	79	က	18	14	2	2	99	က	15	12	4	7
Nonprofits	1990	926	909	19	63	7	223	15	65	5	7	0	24	2
	1995	847	542	21	82	က	180	17	64	2	9	0	21	7
All other	1990 1995	406 334	252 209	- 1	65 50	- 0	4 t	63 50	62 63	ကက	16 15	00	ω 4	16 5
				!		Chomietn	i cto		}	,	:	,	•	!
							ou y							
Academic	1990	32,470	27,910	2,597	896	745	262	29	98	ω	က	2	-	0
	1995	33,822	28,892	2,907	826	632	459	75	82	6	က	2	-	0
Industry	1990	4,845	2,350	2,127	205	27	77	6	49	44	4	2	7	0
	1995	3,986	1,891	1,766	179	26	9/	18	47	44	4	-	7	0
Federal Government	1990	1,553	629	200	609	35	24	7	44	13	33	7	7	0
	1995	1,516	889	180	280	24	31	13	45	12	38	2	7	-
FFRDCs	1990	923	486	81	27	323	2	0	53	6	က	35	-	0
	1995	953	571	74	35	269	7	_	09	80	က	28	-	0
Nonprofits	1990	439	233	71	58	ω	96	5	53	16	9	7	22	0
	1995	821	467	88	58	10	252	4	22	10	က	-	8	0
All other	1990	132	80	17	13	ო	4	17	61	13	10	2	က	13
	1995	116	20	28	21	3	2	6	43	24	18	3	4	8
						Physics	cs							
Academic	1990	38,039	27,217	6,001	1,368	2,912	489	53	72	16	4	8	-	0
	1995	38,027	28,951	4,444	1,511	2,616	446	28	92	12	4	7	-	0
Industry	1990	9,524	3,209	5,473	329	429	09	24	34	22	က	2	-	0
	1995	4,941	2,012		242	241	51	18	41	48	2	2	-	0
Federal Government	1990	3,066	1,261	578	926	198	34	17	4	19	32	9	-	-
	1995	2,801	1,328	405	887	134	38	6	47	14	32	2	-	0
FFRDCs	1990	4,959	2,206	761	152	1,773	09	7	44	15	က	36	-	0
	1995	4,339	2,159	444	160	1,527	45	7	20	10	4	35	-	0
Nonprofits	1990	764	383	125	46	53	150	7	20	16	9	7	20	-
	1995	551	333	40	59	46	103	-	09	7	2	ω	19	0
All other	1990	110	46	25	6	22	4	က	42	23	∞	20	4	က
	1995	81	42	20	7	S	5	2	52	25	တ	9	5	9

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Appendix table 5-47. Distributions in U.S. scientific and technical articles to other U.S. scientific and technical articles, by sector and field: 1990 and 1995

				Numbe	Number of citations to:	ns to:				Percer	Percent of citations to:	ns to:		
Citing sector	Citing year	All sectors	Academia	Industry	Federal Govt.	FFRDCs	Non- profits	Others	Academia	Industry	Federal Govt.	FFRDCs	Non- profits	Others
					Ë	Earth and space sciences	ce science	s						
Academic	1990	18,852	13,756	784	2,179	1,178	821	134	73	4	12	9	4	-
	1995	23,977	17,420	885	2,703	1,421	1,332	216	73	4	Ξ	9	9	-
Industry	1990	1,247	610	286	214	70	43	25	49	23	17	9	က	2
	1995	1,367	638	278	279	103	44	56	47	20	20	∞	ო	2
Federal Government	1990	3,918	1,972	186	1,348	249	120	43	20	2	34	9	က	-
	1995	4,595	2,301	274	1,484	333	150	53	20	9	32	7	က	-
FFRDCs	1990	1,795	934	74	200	508	72	9	52	4	Ξ	28	4	0
	1995	2,765	1,481	105	379	654	127	18	54	4	4	24	2	-
Nonprofits	1990	1,795	1,133	55	150	122	327	œ	63	က	œ	7	18	0
	1995	2,014	1,283	45	169	94	408	14	64	2	œ	2	20	-
All other	1990	300	157	23	4	7	4	25	52	ω	15	4	2	17
	1995	262	146	24	31	12	12	36	26	6	12	2	2	14
					Ē	Engineering &	technology	λ						
Academic	1990	9,295	7,104	1,348	433	291	86	22	92	15	5	က	-	0
	1995	9,115	7,071	1,194	206	214	102	28	78	13	9	2	-	0
Industry	1990	2,490	925	1,319	143	29	35	10	37	53	9	7	-	0
	1995	1,831	774	871	103	46	23	12	42	48	9	က	-	-
Federal Government	1990	869	343	127	366	24	7	-	39	15	42	က	-	0
	1995	266	407	159	384	28	16	4	4	16	ලි	က	7	0
FFRDCs	1990	486	169	29	25	219	2	-	35	41	2	45	-	0
	1995	433	175	29	31	151	o	-	40	15	7	35	7	0
Nonprofits	1990	184	87	30	=	Ξ	44	7	47	16	9	9	24	-
	1995	131	25	24	Ξ	4	33	5	44	18	œ	က	22	5
All other	1990	80	42	24	9	-	က	2	53	30	∞	-	4	9
	1995	43	22	13	4	-	0	က	51	30	0	2	0	7
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Appendix table 5-47. Distribution of citations in U.S. scientific and technical articles, by sector and field: 1990 and 1995

				Numb	Number of citations to:	ns to:				Percel	Percent of citations to:	ns to:		
Citing sector	Citing year	All sectors	All sectors Academia Indu	Industry	Federal Govt.	FFRDCs	Non- profits	Others	Academia Industry	Industry	Federal Govt.	FFRDCs	Non- profits	Others
						Mathematics	natics							
Academic	1990	3,056	2,797	119	49	43	47	-	92	4	2	-	2	0
	1995	2,606	2,411	92	4	25	46	7	93	က	2	_	2	0
Industry	1990	126	9/	37	9	2	-	-	09	29	2	4	-	-
	1995	107	74	27	2	-	က	0	69	25	2	-	က	0
Federal Government	1990	130	88	ω	56	2	4	0	89	9	20	2	က	0
	1995	75	46	4	22	-	-	-	61	2	29	-	-	-
FFRDCs	1990	26	40	က	0	12	-	0	71	2	0	21	2	0
	1995	39	24	2	က	6	_	0	62	2	ω	23	က	0
Nonprofits	1990	62	20	7	2	0	ω	0	81	က	က	0	13	0
	1995	89	20	က	က	0	11	-	74	4	4	0	16	-
All other	1990	27	20	-	-	0	_	ო	74	4	4	0	4	7
	1995	12	6	-	0	0	-	-	75	8	0	0	8	8

FFRDC = federally funded research and development center

NOTE: Details may not add to totals because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

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Appendix table 5-48. Distribution of citations in U.S. scientific and technical articles across broad and fine fields: 1994-95

					Percen	Percentage of cited articles in:	icles in:			
Broad/fine field of citing article	Number of cited articles	Same fine field	Clinical medicine	Biomedical research	Biology	Chemistry	Physics	Earth & space sciences	Engineering & technology	Mathe- matics
				Broad field						
Clinical medicine	920,375	A	73	26	-	0	0	0	0	0
Biomedical research	651,297	Ϋ́	17	77	2	2	_	-	0	0
Biology	106,508	Ϋ́	9	27	62	-	0	4	0	0
Chemistry	196,606	Ϋ́	က	=	-	69	12	2	2	0
Physics	246,357	Ϋ́	-	4	0	7	83	2	4	0
Earth & space science	114,848	Ϋ́	-	80	က	-	က	83	-	0
Engineering & technology	53,137	N A	-	2	-	∞	20	က	64	7
Mathematics	096'6	A V	7	5	0	0	∞	-	o	79
			5	Clinical medicine	•					
Addictive diseases	4,750	30	85	14	1	0	0	0	0	0
Allergy	4,251	21	80	19	-	0	0	0	0	0
Anesthesiology	8,799	47	06	6	-	0	0	0	0	0
Arthritis & rheumatism	9,337	33	84	16	-	0	0	0	0	0
Cancer	72,060	39	69	30	-	0	0	0	0	0
Cardiovascular system	57,970	20	78	21	-	0	0	0	0	0
Dentistry	7,461	09	86	13	-	0	0	0	0	0
Dermatology & venereal disease	13,238	34	74	25	-	0	0	0	0	0
Endocrinology	44,651	33	61	38	-	0	0	0	0	0
Fertility	8,012	30	69	26	2	0	0	0	0	0
Gastroenterology	21,768	32	75	24	-	0	0	0	0	0
General & internal medicine	75,753	25	77	22	-	0	0	0	0	0
Geriatrics	5,381	24	62	21	-	0	0	0	0	0
Hematology	30,550	30	64	35	0	0	0	0	0	0
Hygiene & public health	11,701	30	78	13	က	-	0	4	0	-
Immunology	121,214	44	63	36	-	0	0	0	0	0
Miscellaneous clinical medicine	2,940	27	73	26	0	0	0	0	0	0
Nephrology	11,308	24	64	35	-	0	0	0	0	0
Neurology, neurosurgery	125,305	51	69	30	-	0	0	0	0	0
Obstetrics, gynecology	12,713	44	88	=	0	0	0	0	0	0
Ophthalmology	13,023	29	62	20	0	0	0	0	0	0
Orthopedics	4,361	63	87	13	0	0	0	0	0	0
Otorhinolaryngology	7,687	51	87	6	0	0	4	0	0	0
Pathology	20,835	21	70	30	-	0	0	0	0	0
Pediatrics	15,042	28	82	17	0	0	0	0	0	0
Pharmacology	92,961	31	29	30	-	7	0	0	0	0
Pharmacy	4,346	14	71	15	-	12	0	0	0	0
Psychiatry	13,391	29	92	2	0	0	0	0	0	0
Radiology & nuclear medicine	29,328	22	06	7	0	-	-	0	-	0
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Appendix table 5-48. Distribution of citations in U.S. scientific and technical articles across broad and fine fields: 1994-95

					Percent	Percentage of cited articles in:	icles in:			
Broad/fine field of citing article	Number of cited articles	Same fine field	Clinical medicine	Biomedical research	Biology	Chemistry	Physics	Earth & space sciences	Engineering & technology	Mathe- matics
Respiratory system	14,250	28	82	18	0	0	0	0	0	0
Surgery	30,428	49	06	o	0	0	0	0	0	0
Tropical medicine	1,747	17	09	32	9	0	0	0	0	0
Urology	12,299	49	91	6	0	0	0	0	0	0
Veterinary medicine	11,581	42	71	22	7	0	0	0	0	0
			Biol	Biomedical research	ch					
Anatomy & morphology	3,833	6	30	65	2	0	0	0	0	0
Biochemistry & molecular biology	300,619	20	13	83	2	2	0	0	0	0
Biomedical engineering	8,153	23	24	09	ო	7	-	7	က	0
Biophysics	8,934	4	10	78	-	9	4	0	0	0
Cell biology, cytology & histology	54,087	21	21	77	2	0	0	0	0	0
Embryology	8,718	19	15	84	-	0	0	0	0	0
General biomedical research	73,897	27	22	99	4	2	2	က	0	0
Genetics & heredity	40,393	29	13	81	9	0	0	0	0	0
Microbiology	41,026	43	15	78	4	-	0	-	0	0
Microscopy	2,813	15	26	49	2	က	16	0	က	0
Miscellaneous biomedical research	5,179	17	43	20	7	7	-	-	-	-
Nutrition & dietetics	11,477	30	39	55	9	-	0	0	0	0
Parasitology	5,283	28	23	20	7	0	0	0	0	0
Physiology	48,332	33	35	62	2	0	0	0	0	0
Virology	38,594	47	14	85	-	0	0	0	0	0
				Biology						
Agriculture & food science	17,844	51	2	17	89	4	0	2	-	0
Botany	35,776	20	-	35	61	2	0	-	0	0
Dairy & animal science	8,423	61	18	14	29	0	0	0	0	0
Ecology	9,726	48	-	17	77	0	0	4	0	0
Entomology	8,719	22	4	23	71	-	0	0	0	0
General biology	5,606	7	21	62	16	-	0	-	0	0
General zoology	4,665	4	41	38	46	0	0	2	0	0
Marine biology & hydro-biology	10,885	47	က	4	65	0	0	18	0	0
Miscellaneous biology	2,140	32	12	31	47	0	0	7	0	-
Miscellaneous zoology	2,730	37	2	20	73	0	0	-	0	0
				Chemistry						
Analytical chemistry	26,073	55	80	12	ო	29	2	4	-	0
Applied chemistry	1,656	21	2	19	တ	52	က	4	7	0
General chemistry	56,053	36	က	17	7	9	10	7	-	0
Inorganic & nuclear chemistry	15,935	35	-	7	0	88	က	0	-	0
Organic chemistry	34,697	41	2	œ	2	84	-	0	0	0
Physical chemistry	45,934	36	-	တ	0	22	30	2	4	0
Polymers	16,263	64	0	4	0	79	13	0	4	0

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Appendix table 5-48. Distribution of citations in U.S. scientific and technical articles across broad and fine fields: 1994-95

					Percen	Percentage of cited articles in:	icles in:			
3	Number of cited	Same	Clinical	Biomedical	i	:	·	Earth & space	Engineering &	Mathe-
Broad/fine field of citing article	articles	fine field	medicine	research	Biology	Chemistry	Physics	sciences	technology	matics
				Physics						
Acoustics	3,562	62	6	2	0	0	89	2	16	2
Applied physics	51,328	53	0	က	0	9	82	-	∞	0
Chemical physics	41,267	46	-	7	0	22	89	-	-	0
Fluids & plasmas	7,309	22	0	-	0	က	81	9	80	-
General physics	58,507	48	0	4	0	က	98	က	2	-
Miscellaneous physics	721	28	0	0	0	-	70	4	9	18
Nuclear & particle physics	32,739	89	0	-	0	-	94	က	0	0
OpticsSolid state physics	15,811 35,151	50 40	0 0	ന വ	- 0	Ω 4	08 88	ო 0	ත ව	0 0
-			Earth and	gs	suces					
Astronomy & astrophysics	37 421	80	C	4	c	 	4	60	 -	
Farth & planetary science	37,12	20 0	o c	+ 5	· -) -	t (*	20 0) -	o c
Earth & planetaly science	14,002	<u> </u>	οα	5 5	- 5	- დ) -	† C	- 0	o c
Geology	10,617	23) C	ī œ	i v	0 0	۰ ۵	822	1 —	o C
Meteorology & atmospheric science	10,049	61	0	∞	ı (N	1 0	۱4	83	. 0	0
Oceanography & limnology	6,923	29	0	6	13	-	ო	73	-	0
			Engineering	ering and technology	nology					
Aerospace technology	1.951	09	0	0	0	-	17	2	77	က
Chemical engineering	5,233	42	-	9	-	29	Ξ	က	49	0
Civil engineering	1,238	48	0	2	S)	2	က	25	61	2
Computers	4,350	99	က	4	0	2	80	0	77	9
Electrical engineering & electronics	12,153	99	-	2	0	က	27	7	63	က
General engineering	360	13	0	0	0	2	38	4	48	7
Industrial engineering	92	59	0	2	0	0	0	0	95	9
Library & information science	1	27	55	တ	0	6	0	0	27	0
Materials science	11,617	40	0	က	-	10	28	-	28	0
Mechanical engineering	2,607	54	0	-	0	4	16	2	73	က
Metals & metallurgy	6,215	52	0	-	0	∞	18	0	73	0
Misc. engineering & technology	1,273	59	-	4	7	4	15	21	49	7
Nuclear technology	2,656	26	7	5	0	2	23	-	92	0
Operations research & mgmt science	417	59	1	1	0	0	0	2	26	18
				Mathematics						
Applied mathematics	3,458	56	-	2	0	-	13	2	18	64
General mathematics	4,143	78	0	-	0	0	9	0	က	06
Miscellaneous mathematics	260	37	0	0	0	0	2	0	7	87
Probability & statistics	2,098	77	7	4	-	0	5	-	2	80
NA = not available										

NOTE: Citation counts are from U.S. articles published in 1994 and 1995 to U.S. output published in 1990 through 1993, based on the 1985 Science Citation Index journals set. Details may not add to totals because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
		'	All natural sci	ence and engi	natural science and engineering fields					
World	368,934	389,846	403,845	425,346	438,767	100.0	100.0	100.0	100.0	100.0
Jnited States	132,278	137,771	140,833	143,174	142,792	35.9	35.3	34.9	33.7	32.5
Canada	14,440	16,656	17,232	17,958	17,359	3.9	4.3	4.3	4.2	4.0
United Kingdom	30,794	32,256	30,571	31,806	32,980	8.3	8.3	7.6	7.5	7.5
France	18,567	18,422	19,754	21,548	23,811	5.0	4.7	4.9	5.1	5.4
Germany	26,837	27,310	27,353	29,169	30,654	7.3	7.0	6.8	6.9	7.0
Austria	2,160	2,179	2,315	2,522	2,807	9.0	9.0	9.0	9.0	9.0
Belgium	3,309	3,424	3,233	3,488	3,996	0.9	0.9	0.8	0.8	0.0
reland	200	653	999	708	006	0.2	0.2	0.2	0.2	0.2
_uxembourg	13	12	9	15	20	0.0	0.0	0.0	0.0	0.0
Netherlands	5,993	7,079	8,017	8,492	9,239	1.6	1.8	2.0	2.0	2.1
Switzerland	4,801	4,895	4,783	5,423	5,896	1.3	1.3	1.2	1.3	1.3
Other W. Europe	10	2	2	5	6	0.0	0.0	0.0	0.0	0.0
Italy	7,803	9,377	10,720	12,351	14,117	2.1	2.4	2.7	2.9	3.2
Spain	2,362	4,016	5,402	7,578	8,811	9.0	1.0	1.3	1.8	2.0
Portugal	184	232	446	209	764	0.0	0.1	0.1	0.1	0.2
Greece	793	935	1,262	1,431	1,639	0.2	0.2	0.3	0.3	0.4
Turkey	251	326	563	880	1,359	0.1	0.1	0.1	0.2	0.3
Yugoslavia (former)	861	885	1,055	1,399	1,220	0.2	0.2	0.3	0.3	0.3
Slovenia	0	0	0	0	339	0.0	0.0	0.0	0.0	0.1
Croatia	0	0	0	0	434	0.0	0.0	0.0	0.0	0.1
Bosnia	0	0	0	0	2	0.0	0.0	0.0	0.0	0.0
Yugoslavia (current)	0	0	0	0	442	0.0	0.0	0.0	0.0	0.1
Other S. Europe	29	30	38	20	73	0.0	0.0	0.0	0.0	0.0
Denmark	3,198	3,194	3,252	3,408	3,513	6.0	0.8	0.8	0.8	0.8
Sweden	5,846	6,698	6,935	6,700	7,190	1.6	1.7	1.7	1.6	1.6
Norway	1,920	2,072	1,851	2,128	2,180	0.5	0.5	0.5	0.5	0.5
Finland	2,173	2,485	2,499	2,785	3,246	9.0	9.0	9.0	0.7	0.7
celand	34	22	62	82	117	0.0	0.0	0.0	0.0	0.0
Bulgaria	983	1,079	1,114	1,029	779	0.3	0.3	0.3	0.2	0.2
Hungary	2,107	1,907	1,617	1,472	1,469	9.0	0.5	0.4	0.3	0.3
Poland	4,130	3,964	3,759	3,507	3,895	1.1	1.0	6.0	0.8	6.0
Czechoslovakia (former)	3,152	2,886	2,593	2,612	2,431	6.0	0.7	9.0	9.0	9.0
Czech Republic	0	0	0	0	1,577	0.0	0.0	0.0	0.0	0.4
Slovakia	0	0	0	0	854	0.0	0.0	0.0	0.0	0.2
Other E. Europe	649	583	480	504	554	0.2	0.1	0.1	0.1	0.1
JSSR (former)	29,610	30,293	29,992	28,282	21,749	8.0	7.8	7.4	9.9	2.0
Russia	0	0	0	0	17,180	0.0	0.0	0.0	0.0	3.9
Jkraine	0	0	0	0	2,489	0.0	0.0	0.0	0.0	9.0

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	Number of scientific & technical articles published in	& technical a	rticles publishe	d in:	Percen	t of total scient	Percent of total scientific & technical articles published in:	articles publis	ned in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Other former USSR	0	0	0	0	1,623	0:0	0.0	0.0	0:0	0.4
Japan	25,088	29,618	32,832	37,402	39,498	6.8	9.7	8.1	8.8	
China	1,100	1,943	3,761	4,914	6,200	0.3	0.5	6.0	1.2	4.1
Taiwan	366	289	1,470	2,738	3,884	0.1	0.2	0.4	9.0	6.0
South Korea	168	424	911	1,441	2,964	0.0	0.1	0.2	0.3	0.7
Singapore	124	289	409	22.2	891	0.0	0.1	0.1	0.1	0.2
Hong Kong	0	0	628	969	1,091	0.0	0.0	0.2	0.2	0.2
India	11,725	9,586	8,440	8,448	7,851	3.2	2.5	2.1	2.0	1.8
Other Asia	929	957	1,089	1,169	1,397	0.3	0.2	0.3	0.3	0.3
Australia	8,138	8,247	8,487	8,712	9,747	2.2	2.1	2.1	2.0	2.2
New Zealand	1,722	1,703	1,611	1,766	1,830	0.5	0.4	0.4	0.4	0.4
Argentina	892	1,190	1,327	1,261	1,581	0.2	0.3	0.3	0.3	0.4
Brazil	1,438	1,465	1,761	2,540	2,760	0.4	0.4	0.4	9.0	9.0
Chile	561	269	631	694	200	0.2	0.1	0.2	0.2	0.2
Other S. America	517	424	489	585	652	0.1	0.1	0.1	0.1	0.1
Mexico	648	740	878	626	1,408	0.2	0.2	0.2	0.2	0.3
Other C. America	310	259	271	319	343	0.1	0.1	0.1	0.1	0.1
Israel	3,698	4,233	3,982	3,975	4,322	1.0	1.1	1.0	6.0	1.0
Other Near East	773	1,060	1,388	1,153	1,409	0.2	0.3	0.3	0.3	0.3
Egypt	1,060	926	1,118	1,102	1,136	0.3	0.2	0.3	0.3	0.3
Other N. Africa	237	234	298	387	497	0.1	0.1	0.1	0.1	0.1
South Africa	1,782	2,025	2,130	1,936	1,744	0.5	0.5	0.5	0.5	0.4
Nigeria	780	757	651	479	342	0.2	0.2	0.2	0.1	0.1
Kenya	267	251	262	256	253	0.1	0.1	0.1	0.1	0.1
Other S. & C. Africa	685	635	089	777	772	0.2	0.2	0.2	0.2	0.2
			อ	Clinical medicine	a a					
World	116,371	125,532	130,106	133,913	134,576	100.0	100.0	100.0	100.0	100.0
United States	48,072	50,595	50,510	50,326	50,343	41.3	40.3	38.8	37.6	37.4
Canada	4,006	4,817	5,195	5,440	5,065	3.4	3.8	4.0	4.1	3.8
United Kingdom	11,378	13,228	12,956	13,036	12,624	8.6	10.5	10.0	9.7	9.4
France	6,070	5,356	5,865	6,302	6,761	5.2	4.3	4.5	4.7	5.0
Germany	8,180	8,169	8,239	8,873	8,706	7.0	6.5	6.3	9.9	6.5
Austria	1,054	1,027	1,160	1,216	1,260	6.0	0.8	6.0	6.0	6.0
Belgium	1,275	1,274	1,304	1,373	1,444	1.1	1.0	1.0	1.0	1.1
Ireland	327	299	266	282	344	0.3	0.2	0.2	0.2	0.3
Luxembourg	12	2	က	8	7	0.0	0.0	0.0	0.0	0.0
Netherlands	1,910	2,719	3,255	3,241	3,691	1.6	2.2	2.5	2.4	2.7
Switzerland	1,926	1,835	1,880	2,031	2,067	1.7	1.5	4.	1.5	1.5
Other W. Europe	0	0	0	-	2	0.0	0:0	0.0	0.0	0.0

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
taly	2,715	3,608	4,045	4,616	4,957	2.3	2.9	3.1	3.4	3.7
Spain	512	723	1,222	1,911	2,240	0.4	9.0	6.0	1.4	1.7
Portugal	22	26	77	107	129	0.0	0.0	0.1	0.1	0.1
Greece	214	177	286	354	488	0.2	0.1	0.2	0.3	0.4
ſurkey	73	84	197	372	542	0.1	0.1	0.2	0.3	0.4
Yugoslavia (former)	202	194	225	325	259	0.2	0.2	0.2	0.2	0.2
Slovenia	0	0	0	0	49	0.0	0.0	0.0	0.0	0.0
Oroatia	0	0	0	0	108	0.0	0.0	0.0	0.0	0.1
Bosnia	0	0	0	0	က	0.0	0.0	0.0	0.0	0.0
Yugoslavia (current)	0	0	0	0	66	0.0	0.0	0.0	0.0	0.1
Other S. Europe	9	-	=	13	15	0.0	0.0	0.0	0.0	0.0
Denmark	1,692	1,862	1,815	1,590	1,495	1.5	1.5	4.1	1.2	- :
Sweden	3,078	3,616	3,461	3,213	3,167	2.6	2.9	2.7	2.4	2.4
Norway	911	963	857	206	932	0.8	0.8	0.7	0.7	0.7
Finland	1,155	1,325	1,328	1,456	1,555	1.0	1.1	1.0	1.1	1.2
celand	13	21	27	32	48	0.0	0.0	0.0	0.0	0.0
Bulgaria	84	63	83	88	84	0.1	0.1	0.1	0.1	0.1
Hungary	574	492	302	358	274	0.5	0.4	0.2	0.3	0.2
Poland	781	629	434	376	405	0.7	0.5	0.3	0.3	0.3
Czechoslovakia (former)	809	514	541	445	329	0.5	0.4	0.4	0.3	0.3
Czech Republic	0	0	0	0	201	0.0	0.0	0.0	0.0	0.1
Slovakia	0	0	0	0	157	0.0	0.0	0.0	0.0	0.1
Other E. Europe	64	39	31	24	20	0.1	0.0	0.0	0.0	0.0
JSSR (former)	3,797	3,646	3,675	2,201	1,057	3.3	2.9	2.8	1.6	0.8
Russia	0	0	0	0	914	0.0	0.0	0.0	0.0	0.7
Jkraine	0	0	0	0	29	0.0	0.0	0.0	0.0	0.0
Baltic states	0	0	0	0	46	0.0	0.0	0.0	0.0	0.0
Other former USSR	0	0	0	0	38	0.0	0.0	0.0	0.0	0.0
Japan	5,908	7,861	9,559	11,229	11,446	5.1	6.3	7.3	8.4	8.5
China	158	288	443	206	495	0.1	0.2	0.3	0.4	4.0
Taiwan	22	150	299	586	871	0.0	0.1	0.2	0.4	9.0
South Korea	19	24	88	167	337	0.0	0.0	0.1	0.1	0.3
Singapore	49	106	123	166	204	0.0	0.1	0.1	0.1	0.2
Hong Kong	0	0	347	341	394	0.0	0.0	0.3	0.3	0.3
ndia	1,510	1,184	1,059	1,180	922	1.3	6.0	0.8	6.0	0.7
Other Asia	255	267	317	340	393	0.2	0.2	0.2	0.3	0.3
Australia	2,563	2,728	2,954	2,992	3,294	2.2	2.2	2.3	2.2	2.4
New Zealand	208	611	591	629	630	0.4	0.5	0.5	0.5	0.5
Argentina	270	308	332	317	381	0.2	0.2	0.3	0.2	0.3
Brazil	305	297	326	640	632	0.3	0.2	0.3	0.5	0.5

Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	ber of scientifi	c & technical a	Number of scientific & technical articles published in	d in:	Percent	of total scient	Percent of total scientific & technical articles published in:	articles publis	ned in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Other S. America	144	119	140	171	178	0.1	0.1	0.1	0.1	0.1
Mexico	293	247	281	232	270	0.3	0.2	0.2	0.2	0.2
Other C. America	106	102	85	06	86	0.1	0.1	0.1	0.1	0.1
Israel	1,283	1,641	1,511	1,510	1,474	1.1	1.3	1.2	1.1	1.1
Other Near East	238	328	443	450	202	0.2	0.3	0.3	0.3	0.4
Egypt	189	140	149	167	170	0.2	0.1	0.1	0.1	0.1
Other N. Africa	69	26	29	62	103	0.1	0.0	0.1	0.1	0.1
South Africa	750	810	733	262	487	9.0	9.0	9.0	0.4	0.4
Nigeria	295	287	251	202	131	0.3	0.2	0.2	0.2	0.1
Kenya	153	155	154	141	138	0.1	0.1	0.1	0.1	0.1
Other S. & C. Africa	259	305	337	367	383	0.2	0.2	0.3	0.3	0.3
			Bio	Biomedical research	rch					
World	55,303	64,717	68,616	71,502	72,002	100.0	100.0	100.0	100.0	100.0
United States	21,847	24,461	26,541	27,782	28,081	39.5	37.8	38.7	38.9	39.0
Canada	2,254	2,647	2,879	3,072	2,977	4.1	4.1	4.2	4.3	4.1
United Kingdom	4,709	5,301	5,043	5,385	5,758	8.5	8.2	7.3	7.5	8.0
France	2,883	3,251	3,423	3,789	4,013	5.2	2.0	5.0	5.3	5.6
Germany	3,915	3,963	4,358	4,346	4,559	7.1	6.1	6.4	6.1	6.3
Austria	179	212	263	328	343	0.3	0.3	0.4	0.5	0.5
Belgium	547	613	621	654	969	1.0	6.0	6.0	6.0	1.0
Ireland	99	85	26	87	170	0.1	0.1	0.1	0.1	0.2
Luxembourg	0	4	0	7	2	0.0	0.0	0.0	0.0	0.0
Netherlands	1,107	1,313	1,390	1,564	1,620	2.0	2.0	2.0	2.2	2.2
Switzerland	229	817	825	975	1,037	1.2	1.3	1.2	4.1	1.4
Other W. Europe	0	0	0	-	0	0.0	0.0	0.0	0.0	0.0
Italy	1,109	1,378	1,535	1,766	2,039	2.0	2.1	2.2	2.5	2.8
Spain	490	745	1,010	1,190	1,356	6:0	1.2	1.5	1.7	1.9
Portugal	33	40	89	26	135	0.1		0.1	0.1	0.2
Greece	65	107	109	114	132	0.1	0.2	0.2	0.2	0.2
Turkey	23	25	28	62	93	0.0	0.0	0.0	0.1	0.1
Yugoslavia (former)	152	26	136	140	108	0.3	0.1	0.2	0.2	0.1
Slovenia	0	0	0	0	43	0.0	0.0	0.0	0.0	0.1
Croatia	0	0	0	0	56	0.0	0.0	0.0	0.0	0.0
Bosnia	0	0	0	0	0	0.0	0:0	0.0	0.0	0.0
Yugoslavia (current)	0	0	0	0	39	0.0	0.0	0.0	0.0	0.1
Other S. Europe	2	_	-	7	∞	0.0	0.0	0.0	0.0	0.0
Denmark	468	476	533	663	602	0.8	0.7	0.8	6:0	0.8
Other former USSR	0	0	0	0	1,623	0.0	0.0	0.0	0.0	9.4
Sweden	1,030	1,172	1,299	1,204	1,223	1.9	1.8	1.9	1.7	1.7
Norway	297	319	294	317	298	0.5	0.5	9.4	4.0	0.4
Finland	310	383	365	380	450	9.0	9.0	0.5	0.5	9.0

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	ber of scientifi	c & technical a	Number of scientific & technical articles published in	d in:	Percent	of total scient	Percent of total scientific & technical articles published in:	articles publis	hed in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Iceland	ဇ	6	13	13	16	0.0	0.0	0.0	0.0	0:0
Bulgaria	211	540	502	261	78	0.4	0.8	0.7	0.4	0.1
Hungary	397	335	342	239	215	0.7	0.5	0.5	0.3	0.3
Poland	572	470	367	427	297	1.0	0.7	0.5	9.0	0.4
Czechoslovakia (former)	452	367	371	440	352	0.8	9.0	0.5	9.0	0.5
Czech Republic	0	0	0	0	236	0.0	0.0	0.0	0.0	0.3
Slovakia	0	0	0	0	117	0.0	0.0	0.0	0.0	0.2
Other E. Europe	84	53	26	13	20	0.2	0.1	0.0	0.0	0.0
USSR (former)	3,148	5,618	5,177	4,473	2,716	5.7	8.7	7.5	6.3	3.8
Russia	0	0	0	0	2,401	0.0	0.0	0.0	0.0	3.3
Ukraine	0	0	0	0	131	0.0	0.0	0.0	0.0	0.2
Baltic states	0	0	0	0	48	0.0	0.0	0.0	0.0	0.1
Other former USSR	0	0	0	0	136	0.0	0.0	0.0	0.0	0.2
Japan	3,429	4,339	5,175	5,843	6,125	6.2	6.7	7.5	8.2	8.5
China	49	179	294	381	464	0.1	0.3	0.4	0.5	9.0
Taiwan	27	26	135	255	341	0.0	0.1	0.2	0.4	0.5
South Korea	12	27	65	112	238	0.0	0.0	0.1	0.2	0.3
Singapore	13	25	47	78	93	0.0	0.0	0.1	0.1	0.1
Hong Kong	0	0	89	62	85	0.0	0.0	0.1	0.1	0.1
India	1,605	1,622	1,324	1,022	1,043	2.9	2.5	1.9	1.4	4.1
Other Asia	66	121	131	132	148	0.2	0.2	0.2	0.2	0.2
Australia	1,037	1,221	1,289	1,327	1,405	1.9	1.9	1.9	1.9	2.0
New Zealand	176	208	175	230	203	0.3	0.3	0.3	0.3	0.3
Argentina	182	258	224	190	264	0.3	0.4	0.3	0.3	0.4
Brazil	266	332	436	454	497	0.5	0.5	9.0	9.0	0.7
Chile	112	89	104	92	66	0.2	0.1	0.2	0.1	0.1
Other S. America	106	78	74	98	84	0.2	0.1	0.1	0.1	0.1
Mexico	22	113	130	163	225	0.1	0.2	0.2	0.2	0.3
Other C. America	37	30	36	09	64	0.1	0.0	0.1	0.1	0.1
Israel	554	643	296	629	646	0.0	1.0	6.0	6.0	6.0
Other Near East	89	103	94	73	92	0.1	0.2	0.1	0.1	0.1
Egypt	104	44	29	92	74	0.2	0.1	0.1	0.1	0.1
Other N. Africa	19	20	17	56	37	0.0	0.0	0.0	0.0	0.1
South Africa	154	258	346	278	247	0.3	0.4	0.5	0.4	0.3
Nigeria	78	93	20	37	59	0.1	0.1	0.1	0.1	0.0
Kenya	30	31	48	33	37	0.1	0.0	0.1	0.0	0.1
Other S. & C. Africa	47	54	61	27	74	0.1	0.1	0.1	0.1	0.1
				Biology						
World	39,232	34,896	34,199	34,559	34,988	100.0	100.0	100.0	100.0	100.0
United States	14,740	13,083	12,726	12,062	11,167	37.6	37.5	37.2	34.9	31.9
Canada	2,456	2,884	2,813	2,729	2,401	6.3	8.3	8.2	7.9	6.9

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	Number of scientifi	s & technical a	scientific & technical articles published in:	id in:	Percen	t of total scien	tific & technica	Percent of total scientific & technical articles published in:	hed in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
United Kingdom	3,525	3,087	2,654	2,511	2,672	9.0	8.8	7.8	7.3	7.6
France	1,369	1,151	1,164	1,329	1,380	3.5	3.3	3.4	3.8	3.9
Germany	2,373	1,890	1,817	1,625	1,841	0.9	5.4	5.3	4.7	5.3
Austria	136	133	140	157	146	0.3	0.4	0.4	0.5	0.4
Belgium	293	355	229	184	275	0.7	1.0	0.7	0.5	0.8
Ireland	92	82	82	51	98	0.2	0.2	0.2	0.1	0.2
Luxembourg	-	-	0	-	-	0.0	0.0	0.0	0.0	0.0
Netherlands	612	809	069	730	885	1.6	1.7	2.0	2.1	2.5
Switzerland	236	214	227	252	308	9.0	9.0	0.7	0.7	6.0
Other W. Europe	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
Italy	452	345	424	552	999	1.2	1.0	1.2	1.6	1.9
Spain	256	267	501	885	992	0.7	0.8	1.5	2.6	2.8
Portugal	∞	7	42	64	92	0.0	0.0	0.1	0.2	0.3
Greece	29	84	107	138	154	0.2	0.2	0.3	0.4	0.4
Turkey	19	28	37	49	65	0.0	0.1	0.1	0.1	0.2
Yugoslavia (former)	26	35	43	22	09	0.1	0.1	0.1	0.2	0.2
Slovenia	0	0	0	0	7	0.0	0.0	0.0	0.0	0.0
Croatia	0	0	0	0	25	0.0	0.0	0.0	0.0	0.1
Bosnia	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
Yugoslavia (current)	0	0	0	0	24	0.0	0.0	0.0	0.0	0.1
Other S. Europe	13	15	o	10	80	0.0	0.0	0.0	0.0	0.0
Denmark	258	190	205	280	357	0.7	0.5	9.0	0.8	1.0
Sweden	372	366	496	529	574	6.0	1.0	1.5	1.5	1.6
Norway	250	275	232	276	277	9.0	0.8	0.7	0.8	0.8
Finland	142	151	185	252	288	0.4	0.4	0.5	0.7	0.8
Iceland	က	9	7	19	15	0.0	0.0	0.0	0.1	0.0
Bulgaria	20	28	53	44	42	0.2	0.1	0.2	0.1	0.1
Hungary	192	118	94	62	74	0.5	0.3	0.3	0.2	0.2
Poland	226	195	187	196	170	9.0	9.0	0.5	9.0	0.5
Czechoslovakia (former)	547	421	129	176	164	4.1	1.2	0.4	0.5	0.5
Czech Republic	0	0	0	0	117	0.0	0.0	0.0	0.0	0.3
Slovakia	0	0	0	0	46	0.0	0.0	0.0	0.0	0.1
Other E. Europe	13	9	က	4	4	0.0	0.0	0.0	0.0	0.0
USSR (former)	1,113	936	296	828	927	2.8	2.7	2.3	2.5	2.6
Russia	0	0	0	0	792	0.0	0.0	0.0	0.0	2.3
Ukraine	0	0	0	0	51	0.0	0.0	0.0	0.0	0.1
Baltic states	0	0	0	0	32	0.0	0.0	0.0	0.0	0.1
Other former USSR	0	0	0	0	52	0.0	0.0	0.0	0.0	0.1
Japan	2,404	2,456	2,363	2,537	2,609	6.1	7.0	6.9	7.3	7.5
China	178	156	136	189	223	0.5	0.4	0.4	0.5	9.0
Taiwan	63	71	153	204	253	0.2	0.2	0.4	9.0	0.7
11 90 00000										

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	ber of scientifi	c & technical a	Number of scientific & technical articles published in	d in:	Percent	of total scient	ific & technical	Percent of total scientific & technical articles published in:	ned in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
South Korea	6	14	25	39	87	0.0	0.0	0.1	0.1	0.2
Singapore	80	17	32	40	39	0.0	0.0	0.1	0.1	0.1
Hong Kong	0	0	23	14	29	0.0	0.0	0.1	0.0	0.2
India	1,927	857	775	730	574	4.9	2.5	2.3	2.1	1.6
Other Asia	266	235	274	306	331	0.7	0.7	0.8	6:0	6.0
Australia	1,803	1,666	1,720	1,726	1,811	4.6	4.8	5.0	5.0	5.2
New Zealand	540	465	432	466	515	1.4	1.3	1.3	1.3	1.5
Argentina	108	123	152	174	226	0.3	0.4	0.4	0.5	9.0
Brazil	205	149	149	226	264	0.5	0.4	0.4	0.7	0.8
Chile	61	70	89	29	82	0.2	0.2	0.2	0.2	0.2
Other S. America	102	84	105	119	126	0.3	0.2	0.3	0.3	0.4
Mexico	49	87	116	165	227	0.1	0.2	0.3	0.5	9.0
Other C. America	106	69	82	84	94	0.3	0.2	0.2	0.2	0.3
Israel	440	407	417	378	390	1.1	1.2	1.2	1.1	1.1
Other Near East	106	100	142	121	122	0.3	0.3	0.4	0.4	0.3
Egypt	146	111	126	113	101	0.4	0.3	0.4	0.3	0.3
Other N. Africa	23	28	34	34	38	0.1	0.1	0.1	0.1	0.1
South Africa	296	329	383	355	360	0.8	6.0	1.1	1.0	1.0
Nigeria	226	217	190	127	110	9.0	9.0	9.0	0.4	0.3
Kenya	62	51	43	29	92	0.2	0.1	0.1	0.2	0.2
Other S. & C. Africa	262	176	173	209	196	0.7	0.5	0.5	9.0	9.0
				Chemistry						
World	54,432	55,268	56,126	59,500	61,221	100.0	100.0	100.0	100.0	100.0
United States	10,880	11,585	12,405	12,926	12,900	20.0	21.0	22.1	21.7	21.1
Canada	1,670	1,726	1,653	1,774	1,808	3.1	3.1	2.9	3.0	3.0
United Kingdom	3,610	3,287	3,142	3,356	3,573	9.9	5.9	5.6	5.6	5.8
France	3,199	3,261	3,231	3,462	3,665	5.9	5.9	5.8	5.8	0.9
Germany	4,587	5,139	4,864	5,014	5,499	8.4	9.3	8.7	8.4	9.0
Austria	289	302	271	301	348	0.5	0.5	0.5	0.5	9.0
Belgium	452	442	386	458	528	0.8	0.8	0.7	0.8	6.0
Ireland	84	22	09	96	74	0.2	0.1	0.1	0.2	0.1
Luxembourg	0	-	-	2	-	0.0	0.0	0.0	0.0	0.0
Netherlands	833	755	828	901	876	1.5	4.	1.5	1.5	4.1
Switzerland	653	672	584	713	756	1.2	1.2	1.0	1.2	1.2
Other W. Europe	0	0	-	0	က	0.0	0.0	0.0	0.0	0.0
Italy	1,462	1,518	1,631	1,815	1,931	2.7	2.7	2.9	3.1	3.2
Spain	829	1,411	1,326	1,756	1,901	1.2	2.6	2.4	3.0	3.1
Portugal	26	22	77	111	140	0.0	0.0	0.1	0.2	0.2
Greece	94	159	232	219	264	0.2	0.3	9.0	0.4	0.4
Turkey	26	22	105	146	265	0.0	0.1	0.2	0.2	0.4

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Nun	Number of scientifi	scientific & technical articles published in:	rticles publishe	ed in:	Percent	t of total scien	Percent of total scientific & technical articles published in:	articles publis	hed in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Yugoslavia (former)	199	246	263	396	332	0.4	0.4	0.5	0.7	0.5
Slovenia	0	0	0	0	92	0.0	0.0	0.0	0.0	0.2
Croatia	0	0	0	0	141	0.0	0.0	0.0	0.0	0.2
Bosnia	0	0	0	0	-	0.0	0.0	0.0	0.0	0.0
Yugoslavia (current)	0	0	0	0	92	0.0	0.0	0.0	0.0	0.2
Other S. Europe	0	-	10	4	7	0.0	0.0	0.0	0.0	0.0
Denmark	223	179	184	221	283	0.4	0.3	0.3	0.4	0.5
Sweden	200	511	542	592	642	6.0	6.0	1.0	1.0	1.0
Norway	174	176	156	174	198	0.3	0.3	0.3	0.3	0.3
Finland	167	192	172	175	267	0.3	0.3	0.3	0.3	0.4
Iceland	0	2	က	2	4	0.0	0.0	0.0	0.0	0.0
Bulgaria	309	197	217	298	257	9.0	0.4	0.4	0.5	0.4
Hungary	222	504	482	460	490	1.0	6.0	6:0	0.8	8.0
Poland	1,233	1,318	1,138	1,024	1,263	2.3	2.4	2.0	1.7	2.1
Czechoslovakia (former)	961	978	925	803	782	1.8	1.8	1.6	1.3	1.3
Czech Republic	0	0	0	0	492	0.0	0.0	0.0	0.0	0.8
Slovakia	0	0	0	0	290	0.0	0.0	0.0	0.0	0.5
Other E. Europe	233	212	245	277	223	0.4	0.4	0.4	0.5	0.4
USSR (former)	9,077	8,462	8,164	7,806	000'9	16.7	15.3	14.5	13.1	8.6
Russia	0	0	0	0	4,799	0.0	0.0	0.0	0.0	7.8
Ukraine	0	0	0	0	563	0.0	0.0	0.0	0.0	6.0
Baltic states	0	0	0	0	103	0.0	0.0	0.0	0.0	0.2
Other former USSR	0	0	0	0	535	0.0	0.0	0.0	0.0	6.0
Japan	5,926	2,887	2,907	6,620	6,694	10.9	10.7	10.5	11.1	10.9
China	89	185	268	961	1,463	0.2	0.3	1.0	1.6	2.4
Taiwan	78	123	226	491	694	0.1	0.2	0.4	0.8	- -
South Korea	49	139	317	465	829	0.1	0.3	9.0	0.8	4.1
Singapore	∞	31	99	81	118	0.0	0.1	0.1		0.2
Hong Kong	0	0	28	96	152	0.0	0.0	0.1	0.2	0.2
India	3,191	2,674	2,535	2,400	2,376		4.8	4.5	4.0	3.9
Other Asia	91	114	136	163	234	0.2	0.2	0.2	0.3	4.0
Australia	926	774	763	764	890	1.7	1.4	1.4	1.3	1.5
New Zealand	154	113	126	132	152	0.3	0.2	0.2	0.2	0.2
Argentina	135	214	225	218	232	0.2	4.0	9.4	0.4	9.4
Brazil	180	155	168	250	333	0.3	0.3	0.3	0.4	0.5
Chile	09	28	80	93	75	0.1	0.1	0.1	0.2	0.1
Other S. America	65	25	51	63	84	0.1	0.1	0.1	0.1	0.1
Mexico	29	29	87	108	192	0.1	0.1	0.2	0.2	0.3
Other C. America	31	16	27	32	42	0.1	0.0	0.0	0.1	0.1
Israel	345	374	338	281	323	9.0	0.7	9.0	0.5	0.5
Other Near East	121	177	251	165	233	0.2	0.3	9.4	0.3	9.4
Egypt	383	395	475	426	440	0.7	0.7	0.8	0.7	0.7

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	ber of scientifi	c & technical a	Number of scientific & technical articles published in:	id in:	Percent	of total scient	Percent of total scientific & technical articles published in:	articles publist	led in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Other N. Africa	54	54	94	115	147	0.1	0.1	0.2	0.2	0.2
South Africa	202	192	222	216	190	0.4	0.3	0.4	0.4	0.3
Nigeria	74	52	54	46	28	0.1	0.1	0.1	0.1	0.0
Kenya	4	7	က	2	7	0.0	0.0	0.0	0.0	0.0
Other S. & C. Africa	43	37	36	39	30	0.1	0.1	0.1	0.1	0.0
				Physics						
World	45,561	54,044	61,449	096'99	74,221	100.0	100.0	100.0	100.0	100.0
United States	13,053	15,903	17,649	17,847	17,882	28.6	29.4	28.7	26.7	24.1
Canada	1,335	1,732	1,668	1,800	1,834	2.9	3.2	2.7	2.7	2.5
United Kingdom	2,904	3,026	3,048	3,446	3,955	6.4	5.6	5.0	5.1	5.3
France	2,671	3,218	3,590	3,825	4,581	5.9	0.9	5.8	5.7	6.2
Germany	3,493	4,316	4,832	5,583	6,499	7.7	8.0	7.9	8.3	8.8
Austria	239	258	271	302	435	0.5	0.5	0.4	0.5	9.0
Belgium	377	407	425	515	642	0.8	0.8	0.7	0.8	6.0
Ireland	52	28	20	87	127	0.1	0.1	0.1	0.1	0.2
Luxembourg	0	-	-	0	2	0.0	0.0	0.0	0.0	0.0
Netherlands	803	870	1,008	1,104	1,152	1.8	1.6	1.6	1.6	1.6
Switzerland	736	877	876	1,011	1,187	1.6	1.6	4.1	1.5	1.6
Other W. Europe	6	2	4	7	2	0.0	0.0	0.0	0.0	0.0
Italy	1,150	1,513	1,819	2,131	2,746	2.5	2.8	3.0	3.2	3.7
Spain	259	535	735	1,037	1,335	9.0	1.0	1.2	1.5	1.8
Portugal	32	48	82	105	127	0.1	0.1	0.1	0.2	0.2
Greece	131	159	215	258	270	0.3	0.3	0.3	0.4	0.4
Turkey	35	49	22	62	146	0.1	0.1	0.1	0.1	0.2
Yugoslavia (former)	149	193	217	285	270	0.3	0.4	0.4	0.4	0.4
Slovenia	0	0	0	0	88	0.0	0.0	0.0	0.0	0.1
Croatia	0	0	0	0	80	0.0	0.0	0.0	0.0	0.1
Bosnia	0	0	0	0	-	0.0	0.0	0.0	0.0	0.0
Yugoslavia (current)	0	0	0	0	101	0.0	0.0	0.0	0.0	0.1
Other S. Europe	0	2	-	4	17	0.0	0.0	0.0	0.0	0.0
Denmark	301	267	289	326	411	0.7	0.5	0.5	0.5	9.0
Sweden	360	501	298	629	889	0.8	6.0	1.0	6.0	1.2
Norway	100	88	92	147	153	0.2	0.2	0.2	0.2	0.2
Finland	167	200	194	238	335	0.4	4.0	0.3	0.4	0.5
Iceland	2	2	က	7	10	0.0	0.0	0.0	0.0	0.0
Bulgaria	189	157	157	232	203	0.4	0.3	0.3	0.3	0.3
Hungary	181	225	203	198	259	0.4	4.0	0.3	0.3	0.3
Poland	799	872	1,131	1,020	1,260	1.8	1.6	1.8	1.5	1.7
Czechoslovakia (former)	285	328	394	415	467	9.0	9.0	9.0	9.0	9.0
Czech Republic	0	0	0	0	318	0.0	0.0	0.0	0.0	9.4

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	ber of scientific	s & technical a	Number of scientific & technical articles published in	id in:	Percent	of total scient	Percent of total scientific & technical articles published in:	articles publish	ned in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Slovakia	0	0	0	0	149	0.0	0.0	0.0	0.0	0.2
Other E. Europe	147	162	94	103	185	0.3	0.3	0.2	0.2	0.2
USSR (former)	7,647	8,422	9,347	9,341	8,300	16.8	15.6	15.2	14.0	11.2
Russia	0	0	0	0	6,106	0.0	0.0	0.0	0.0	8.2
Ukraine	0	0	0	0	1,276	0.0	0.0	0.0	0.0	1.7
Baltic states	0	0	0	0	181	0.0	0.0	0.0	0.0	0.2
Other former USSR	0	0	0	0	737	0.0	0.0	0.0	0.0	1.0
Japan	3,750	4,775	6,116	7,272	8,370	8.2	8.8	10.0	10.9	11.3
China	241	573	1,487	1,868	2,350	0.5	1.1	2.4	2.8	3.2
Taiwan	48	116	258	497	750	0.1	0.2	0.4	0.7	1.0
South Korea	34	88	193	329	829	0.1	0.2	0.3	0.5	1.2
Singapore	10	36	35	29	160	0:0	0.1	0.1	0.1	0.2
Hong Kong	0	0	37	63	189	0:0	0.0	0.1	0.1	0.3
India	1,713	1,578	1,493	1,638	1,665	3.8	2.9	2.4	2.4	2.2
Other Asia	87	88	101	107	123	0.2	0.2	0.2	0.2	0.2
Australia	619	899	613	681	086	4.1	1.2	1.0	1.0	1.3
New Zealand	89	81	89	87	88	0.1	0.1	0.1	0.1	0.1
Argentina	113	188	262	222	309	0.2	0.3	0.4	0.3	0.4
Brazil	279	342	431	612	200	9.0	9.0	0.7	6.0	6.0
Chile	14	42	34	42	22	0.0	0.1	0.1	0.1	0.1
Other S. America	52	48	99	98	106	0.1	0.1	0.1	0.1	0.1
Mexico	102	149	152	179	323	0.2	0.3	0.2	0.3	0.4
Other C. America	7	15	18	28	34	0.0	0.0	0.0	0.0	0.0
Israel	504	526	286	614	887	1:1	1.0	1.0	6.0	1.2
Other Near East	29	06	103	87	154	0.1	0.2	0.2	0.1	0.2
Egypt	82	82	119	144	177	0.2	0.2	0.2	0.2	0.2
Other N. Africa	31	30	43	26	92	0.1	0.1	0.1	0.1	0.1
South Africa	93	104	136	150	121	0.2	0.2	0.2	0.2	0.2
Nigeria	24	17	13	12	13	0.1	0:0	0.0	0.0	0.0
Kenya	2	-	4	0	4	0.0	0.0	0.0	0.0	0.0
Other S. & C. Africa	16	14	17	24	33	0.0	0.0	0.0	0.0	0.0
			Earth	and space sciences	ences					
World	16,991	17,834	18,714	20,926	23,187	100.0	100.0	100.0	100.0	100.0
United States	7,257	7,663	7,770	8,233	9,379	42.7	43.0	41.5	39.3	40.4
Canada	888	1,061	1,310	1,352	1,485	5.2	5.9	7.0	6.5	6.4
United Kingdom	1,441	1,475	1,420	1,544	1,850	8.5	8.3	7.6	7.4	8.0
France	774	681	834	929	1,217	4.6	3.8	4.5	4.4	5.2
Germany	833	914	851	1,051	1,181	4.9	5.1	4.5	5.0	5.1
Austria	49	09	51	29	101	0.3	0.3	0.3	0.3	0.4
Belgium	101	123	98	107	140	9.0	0.7	0.5	0.5	9.0

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

Region/country										
	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Ireland	30	30	39	48	41	0.2	0.2	0.2	0.2	0.2
Luxembourg	0	0	0	0	-	0.0	0.0	0.0	0.0	0.0
Netherlands	216	356	359	400	461	1.3	2.0	1.9	1.9	2.0
Switzerland	141	131	129	179	227	0.8	0.7	0.7	6.0	1.0
Other W. Europe	0	0	0	-	0	0.0	0.0	0.0	0.0	0.0
Italy	349	319	440	268	661	2.1	1.8	2.4	2.7	2.9
Spain	55	74	228	325	403	0.3	0.4	1.2	1.6	1.7
Portugal	9	12	23	26	37	0.0	0.1	0.1	0.1	0.2
Greece	62	72	66	122	116	0.4	0.4	0.5	9.0	0.5
Turkey	17	23	45	29	06	0.1	0.1	0.2	0.3	0.4
Yugoslavia (former)	22	33	37	61	22	0.1	0.2	0.2	0.3	0.2
Slovenia	0	0	0	0	41	0.0	0.0	0.0	0.0	0.1
Croatia	0	0	0	0	27	0.0	0.0	0.0	0.0	0.1
Bosnia	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
Yugoslavia (current)	0	0	0	0	16	0.0	0.0	0.0	0.0	0.1
Other S. Europe	7	7	9	ω	=	0.0	0.0	0.0	0.0	0.0
Denmark	88	101	88	149	202	0.5	9.0	0.5	0.7	0.9
Sweden	120	205	236	249	288	0.7	1.1	1.3	1.2	1.2
Norway	82	134	111	177	189	0.5	0.8	9.0	0.8	0.8
Finland	28	84	96	26	153	0.3	0.5	0.5	0.5	0.7
Iceland	7	15	တ	9	19	0.0	0.1	0.0	0.0	0.1
Bulgaria	35	20	29	30	27	0.2	0.1	0.2	0.1	0.1
Hungary	21	56	21	45	51	0.1	0.1	0.1	0.2	0.2
Poland	86	29	82	88	114	0.5	0.4	0.4	0.4	0.5
Czechoslovakia (former)	103	120	75	100	92	9.0	0.7	0.4	0.5	0.4
Czech Republic	0	0	0	0	20	0.0	0.0	0.0	0.0	0.3
Slovakia	0	0	0	0	23	0.0	0.0	0.0	0.0	0.1
Other E. Europe	4	4	9	9	2	0.0	0.0	0.0	0.0	0.0
USSR (former)	1,704	1,271	1,298	1,614	963	10.0	7.1	6.9	7.7	4.2
Russia	0	0	0	0	845	0.0	0.0	0.0	0.0	3.6
Ukraine	0	0	0	0	99	0.0	0.0	0.0	0.0	0.3
Baltic states	0	0	0	0	25	0.0	0.0	0.0	0.0	0.1
Other former USSR	0	0	0	0	27	0.0	0.0	0.0	0.0	0.1
Japan	395	592	737	992	696	2.3	3.3	3.9	3.7	4.2
China	240	268	143	157	196	4.	1.5	0.8	0.8	0.8
Taiwan	12	80	18	22	122	0.1	0.0	0.1	0.3	0.5
South Korea	က	7	17	23	09	0.0	0.0	0.1	0.1	0.3
Singapore	2	Ξ	12	15	15	0.0	0.1	0.1	0.1	0.1
Hong Kong	0	0	Ξ	20	33	0.0	0.0	0.1	0.1	0.1
India	479	208	391	499	380	2.8	2.8	2.1	2.4	1.6
Other Asia	33	38	22	40	69	0.2	0.2	0.3	0.2	0.3
Australia	530	527	612	617	646	3.1	3.0	3.3	2.9	2.8

Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

1961 1965 1589 1987 1986 1987 1986 1989 1982 1989	1981 1985 1989 1992 1986 1981 1981 1981 1981 1981 1981 1981 1981 1981 144 188 1981 141 188 1981 141 188 141 142 143 143 144 145 149 0.0		Num	ber of scientifi	c & technical a	Number of scientific & technical articles published in:	in:	Percent	t of total scient	Percent of total scientific & technical articles published in:	articles publis	ned in:
160 135 128	160 135 128 134 145 0.9 30 36 58 51 70 0.2 47 40 34 66 63 0.2 47 40 34 66 63 0.2 8 9 12 15 0.1 0.2 128 139 145 160 176 0.2 128 139 145 160 0.2 0.0 128 139 145 160 0.1 0.0 13 145 160 176 0.2 0.1 0.0 10 12 16 176 176 0.0	Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
36 56 51 70 0.2 0.2 0.3 0.2 47 40 34 66 68 63 0.3 0.2 0.2 0.3 0.3 47 40 34 66 68 68 0.3 0.2 0.2 0.2 0.2 0.2 0.3 0.3 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.3 0.4 0.3 0.2 0.3 0.4 0.3 0.2 0.3 0.2 0.3 0.2 0.3 0.4 0.3 0.3 0.2 0.3 0.3 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 <td>30 36 58 51 70 0.2 47 40 34 66 63 0.3 47 40 34 66 63 0.3 17 13 14 21 27 0.1 18 139 142 16 105 0.2 18 139 142 16 0.2 0.0 19 29 48 51 42 0.1 106 159 184 207 1.2 0.0 107 2 48 51 42 0.0 108 184 207 12 0.0 1106 159 142 14 0.0 2 2 2 4 0.0 2 2 4 0.0 0.0 2 2 4 0.0 0.0 2 2 4 0.0 0.0 1,304 1,348</td> <td>New Zealand</td> <td>160</td> <td>135</td> <td>128</td> <td>134</td> <td>145</td> <td>6.0</td> <td>0.8</td> <td>0.7</td> <td>9:0</td> <td>9.0</td>	30 36 58 51 70 0.2 47 40 34 66 63 0.3 47 40 34 66 63 0.3 17 13 14 21 27 0.1 18 139 142 16 105 0.2 18 139 142 16 0.2 0.0 19 29 48 51 42 0.1 106 159 184 207 1.2 0.0 107 2 48 51 42 0.0 108 184 207 12 0.0 1106 159 142 14 0.0 2 2 2 4 0.0 2 2 4 0.0 0.0 2 2 4 0.0 0.0 2 2 4 0.0 0.0 1,304 1,348	New Zealand	160	135	128	134	145	6.0	0.8	0.7	9:0	9.0
85 70	86 70 110 163 141 0.5 147 13 34 66 68 63 0.3 148 14 21 27 0.1 148 19 12 12 7 0.1 158 19 14 21 27 0.1 158 19 14 21 27 0.1 158 19 14 21 27 0.1 158 19 14 21 27 0.1 159 148 151 142 0.0 106 159 184 207 229 0.6 107 108 19 14 207 229 0.6 108 19 14 207 229 0.6 108 19 14 207 229 0.6 108 19 12 29 0.6 112,486 10,822 9,684 10.229 40.7 11304 1,348 1,213 1,393 1,422 4.2 11,304 1,348 1,213 1,393 1,432 4.2 11,304 1,348 1,213 1,393 1,432 4.2 11,304 1,348 1,213 1,393 1,432 0.6 11,304 1,348 1,213 1,393 1,432 0.6 11,304 1,348 1,213 1,393 1,432 0.6 11,304 1,348 1,213 1,384 1,134 0.0 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Argentina	30	36	58	51	70	0.2	0.2	0.3	0.2	0.3
47 40 34 66 63 0.3 0.2 0.3	47 40 34 66 63 0.3 33 39 59 60 105 0.1 33 39 59 60 105 0.2 8 9 12 15 8 0.0 18 9 12 16 176 0.2 19 29 48 51 42 0.1 106 159 48 51 42 0.1 106 159 48 51 42 0.1 106 159 184 207 229 0.0 107 7 6 12 4 0.0 29 20 41 0.2 0.2 29 20 25 41 0.2 29 20 25 41 0.0 20 25 41 0.0 0.0 1,248 1,248 1,243 1,43 1,23 1,0	Brazil	85	20	110	163	141	0.5	0.4	9.0	0.8	9.0
17 13 14 21 27 0.1	17 13 14 21 27 0.1 8 9 12 15 60 105 0.2 8 9 12 15 16 0 105 0.0 8 19 12 15 16 0 105 0.0 8 29 82 69 67 0.0 8 184 207 176 0.8 8 19 7 15 19 0.0 8 184 207 229 0.6 8 10,822 2,642 2,644 30,685 10,229 1,304 1,348 1,213 1,393 1,432 4.2 1,322 2,197 1,782 1,991 2,087 8.5 1,322 2,197 1,782 1,991 2,087 8.5 1,322 2,197 1,782 1,991 2,087 8.5 1,324 108 91 1,029 1,383 1,432 7.6 1,32 2,197 1,78 2,119 1,824 0.0 8 43 991 1,02 12 13 1,354 3.3 17 1 308 406 426 12 8 40 2 5 4 8 1 8 1 14 17 12 12 112 143 1,364 1.2 8 40 0 0 1 1 2 00 8 42 84 17 2 533 669 831 1.4 17 12 12 162 183 117 0.0 18 12 162 183 117 0.0 18 12 162 163 183 117 0.0 18 18 102 163 183 117 0.0 18 10 0 0 0 0 0 0 19 0 0 0 0 0 0 11 0 0 0 0 0 0 11 0 0 0 0 0	Chile	47	40	34	99	63	0.3	0.2	0.2	0.3	0.3
33 39 59 60 105 0.2 0.3 0.3 128 19 12 16 8 0.0 0.1 0.1 0.1 128 19 145 16 16 0.0 0.1 0.0 0.1 0.0 0.1 0.0 0.0 0.1 0.0 0.0 0.1 0.0 0.0 0.1 0.0 0.	33 39 59 60 105 0.2 8 139 145 160 176 0.8 33 50 82 69 67 0.0 106 159 184 207 229 0.0 31 42 30 34 14 0.0 29 22 184 207 229 0.0 12,486 10,822 9,568 10,833 1,432 4.2 1,304 1,348 1,213 1,393 1,432 4.2 1,322 2,197 1,782 1,991 2,087 8.5 1,020 843 961 1,213 1,354 3.3 2,596 2,197 1,786 2,119 1,823 0.4 1,75 122 112 112 1,393 1,432 0.0 2 0 0 1 1 2 20 0.0 370 371 308 406 20,56 112 360 283 190 206 235 112 360 283 190 206 235 112 370 371 308 406 0.0 428 472 533 669 831 1,44 72 139 205 312 103 103 428 60 0 0 0 0 0 0 60 0 0 0 0 0 0 60 0 0 0	Other S. America	17	13	14	21	27	0.1	0.1	0.1	0.1	0.1
12	8 9 12 15 15 00 00 00 00 00 00 00 00 00 00 00 00 00	Mexico	33	39	29	09	105	0.2	0.2	0.3	0.3	0.5
128 139 145 140 176 0.8 0.9 0.1 0.0 0.1 0.0 0.1 0.0 0.1 0.0	128 139 145 160 176 0.8 3 3 50 82 69 67 0.2 1 8 9 7 15 19 0.0 1 106 159 184 207 229 0.6 31 42 30 34 14 0.2 29 20 25 41 34 0.2 29 20 25 41 34 0.2 12,486 10,822 9,568 10,833 10,229 40.7 1,304 1,348 1,213 1,393 1,432 4.2 2,522 2,167 1,786 2,119 1,833 0.6 1,34 108 91 102 123 0.4 175 122 112 1,391 1,354 3.3 2,322 2,167 1,786 2,119 1,833 0.0 1 2,322 2,167 1,382 10,229 40.7 1,34 108 91 102 123 0.4 175 122 112 1,393 1,432 0.6 1 2,32 2,62 2,67 1,391 1,354 3.3 2,32 2,167 1,382 0.0 1 2 25 42 0.0 1 30 0 0 1 1 0.0 1 428 472 533 669 831 1.4 17 49 86 102 162 183 174 0.0 1 6 0 0 0 0 0 0 0 1 7 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0	Other C. America	∞	6	12	15	∞	0.0	0.1	0.1	0.1	0.0
33 50 82 69 67 0.2 0.3 0.4 0.3 19 29 7 15 19 0.0 0.1 0.0 0.1 0.0 106 159 184 207 229 0.6 0.9 1.0 0.1 106 159 184 207 229 0.6 0.9 1.0 0.1 29 20 25 41 0.2 0.0 0.0 0.1 0.0 29 20 25 41 0.2 0.1 0.0 0.1 0.0 29 20 25 41 0.2 0.0 0.0 0.1 0.0 29 20 25 41 0.2 0.0 <td>33 50 82 69 67 0.2 19 29 48 51 42 0.1 8 9 7 15 19 0.0 106 159 184 207 229 0.0 31 42 30 34 14 0.0 7 7 6 12 4 0.0 29 20 25 41 4 0.0 29 20 25 41 4 0.0 29 20 25 41 4 0.0 20,710 28,004 25,442 29,684 30,585 100.0 1,020 843 1,782 1,991 2,087 42 1,020 843 1,782 1,991 2,087 42 1,020 843 1,786 2,119 1,323 1,42 1,020 843 1,121 1,432 42 2,366</td> <td>Israel</td> <td>128</td> <td>139</td> <td>145</td> <td>160</td> <td>176</td> <td>0.8</td> <td>0.8</td> <td>0.8</td> <td>0.8</td> <td>0.8</td>	33 50 82 69 67 0.2 19 29 48 51 42 0.1 8 9 7 15 19 0.0 106 159 184 207 229 0.0 31 42 30 34 14 0.0 7 7 6 12 4 0.0 29 20 25 41 4 0.0 29 20 25 41 4 0.0 29 20 25 41 4 0.0 20,710 28,004 25,442 29,684 30,585 100.0 1,020 843 1,782 1,991 2,087 42 1,020 843 1,782 1,991 2,087 42 1,020 843 1,786 2,119 1,323 1,42 1,020 843 1,121 1,432 42 2,366	Israel	128	139	145	160	176	0.8	0.8	0.8	0.8	0.8
19 29 48 51 42 0.1 0.2 0.3 0.2 106 159 184 207 229 0.6 0.9 0.1 0.0 116 159 184 207 229 0.6 0.9 0.1 0.0 12 25 25 21 22 23.84 20.2 20.2 0.0 13 24 25 24 24 24 24 0.2 0.0 0.0 14 25 29 284 30.585 100.0 100.0 0.1 15 25.004 25.442 29.884 30.585 100.0 100.0 100.0 15 25.004 1.248 1.24	19 29 48 51 42 0.1 8 9 7 15 19 0.0 106 159 184 207 229 0.6 31 42 30 34 14 0.2 7 7 6 12 4 0.0 29 20 25 41 34 0.2 29 20 25 41 34 0.0 12,486 10,822 9,568 10,833 10,29 40.7 12,486 10,822 9,568 10,833 10,29 40.7 12,486 10,822 9,568 10,833 10,29 40.7 1,304 1,348 1,213 1,333 1,432 42 1,304 1,782 1,991 1,432 42 40.7 1,020 843 961 1,213 1,432 42 42 1,020 26 25 42 40	Other Near East	33	20	82	69	29	0.2	0.3	4.0	0.3	0.3
8 9 7 15 19 0.0 0.1 0.0 0.1 106 159 184 207 229 0.6 0.9 1.0 0.1 31 47 20 229 0.6 0.9 1.0 0.1 29 20 2 41 4 0.0 0.0 0.0 0.1 29 20 2 41 4 0.0 0.0 0.0 0.1 29 20 2 41 4 0.0 0.0 0.0 0.0 29 20 2 4 0.0 0.0 0.0 0.0 29 2 4 0.0 0.0 0.0 0.0 0.0 10,486 1,213 1,283 1,422 42 4,8 4,8 4,7 1,394 1,283 1,432 42 4,8 4,8 4,7 1,394 1,213 1,823 7,6 7,7	8 9 7 15 15 19 0.0 106 159 184 207 229 0.6 31 42 30 34 14 0.2 37 7 6 6 12 44 0.0 29 20 25 41 34 0.0 29 20 25 41 34 0.0 12,486 10,822 9,568 10,833 10,229 40.7 1,304 1,348 1,213 1,393 1,432 4.2 2,596 2,197 1,782 1,991 2,087 8.5 1,304 1,348 1,213 1,393 1,432 4.2 2,322 2,167 1,786 2,119 1,823 7.6 1,020 843 961 1,213 1,354 3.3 2,322 2,167 1,786 2,119 1,823 7.6 1,020 843 961 10,823 0.0 2 0 0 1 12 12 143 196 0.0 2 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 2 0 0 0 0	Egypt	19	59	48	51	42	0.1	0.2	0.3	0.2	0.2
106 159 184 207 229 0.6 0.9 1.0 1.0 31 42 30 34 14 0.2	106 159 184 207 229 0.6 31 42 30 34 14 0.2 7 7 6 12 4 0.0 29 20 25 41 34 0.0 29 20 25 41 34 0.0 30,710 28,004 25,442 29,684 30,585 100.0 1 12,486 10,822 9,568 10,833 10,229 40.7 10.0 1,20 843 1,243 1,432 4.2	Other N. Africa	∞	6	7	15	19	0.0	0.1	0.0	0.1	0.1
31 42 30 34 14 0.2 0.2 0.2 0.2 29 20 25 41 34 0.2 0.0 0.0 0.1 29 20 25 41 34 0.2 0.0 0.0 0.1 30,710 28,004 25,442 29,684 30,585 100.0 100.0 100.0 12,486 10,822 9,568 10,833 10,299 40,7 38.6 37.6 36.5 1,504 1,348 1,213 1,333 1,422 4.2 4.8 4.8 4.7 2,532 2,167 1,786 2,119 1,823 7.6 7.7 7.0 7.1 1,020 843 961 1,213 1,384 3.3 3.0 8.5 7.7 1,020 843 961 1,213 1,384 3.3 3.0 3.8 4.1 1,021 1,286 2,119 1,823 7.6 7.7 7.0 7.1 1,022 2,322 1,67 1,186 2,119 1,823 7.6 7.7 7.0 7.1 1,020 26 25 42 40 0.1 0.1 0.1 0.1 1,021 1,22 1,23 1,96 0.6 0.4 0.4 0.4 1,021 1,23 1,96 2.06 2.35 1.2 1.1 1.2 1.4 1,021 1,23 1,33 1,4 1,4 1.7 2.1 2.3 1,022 2,32 2,167 1,43 1,44 1.7 2.1 2.3 1,020 2,33 2,06 831 1,4 1.7 2.1 2.3 1,021 1,23 1,23 1,44 1,4 1,4 1,4 1,4 1,021 1,24 1,24 1,24 1,24 1,4 1,4 1,021 1,24 1,24 1,24 1,24 1,4 1,4 1,4 1,021 1,24 1,24 1,24 1,24 1,4 1,4 1,021 1,24 1,24 1,24 1,4 1,4 1,4 1,4 1,021 1,24 1,4 1,4 1,4 1,4 1,4 1,4 1,021 1,03 1,03 1,03 1,03 1,03 1,031 1,031 1,031 1,04 1,4 1,4 1,4 1,4 1,031 1,031 1,031 1,04 1,4 1,4 1,4 1,4 1,4 1,031 1,031 1,031 1,04 1,4 1,4 1,4 1,4 1,4 1,031 1,031 1,031 1,04 1,4 1	31 42 30 34 14 0.2 7 7 7 6 12 4 0.0 29 20 25 41 34 0.0 30,710 28,004 25,442 29,684 30,585 100.0 1 12,486 10,822 9,568 10,833 10,229 40.7 40.7 1,304 1,348 1,213 1,393 1,422 40.7 40.7 1,500 843 961 1,213 1,354 3.3 42.2 40.7 42.2 40.7 42.2 40.7 42.2 40.7 42.2 40.7 42.2 42.2 40.7 42.2	South Africa	106	159	184	207	229	9.0	6.0	1.0	1.0	1.0
7 7 6 12 4 0.0 0.0 0.0 0.0 Engineering and technology Engineering and technology 30,710 28,004 25,442 29,684 30,585 100.0 100.0 100.0 12,486 10,822 9,568 12,933 1,432 4.2 4.8 4.8 4.7 1,2486 10,822 9,568 1,393 1,432 4.2 4.8 4.8 4.7 1,2486 1,348 1,213 1,384 1,291 1,894 4.2 4.8 4.8 4.7 2,596 2,197 1,782 1,432 4.2 4.8 4.8 4.7 <td>7 7 6 12 4 0.0 Engineering and technology Su/710 28,004 25,442 29,684 30,585 100.0 1 12,486 10,822 9,568 10,833 10,229 40.7 40.7 1,304 1,348 1,213 1,393 1,432 40.7 40.7 1,304 1,348 1,213 1,393 1,432 40.7 40.7 2,596 2,197 1,782 1,991 2,087 8.5 40.7 1,304 1,348 1,213 1,432 4.2 40.7 40.7 2,596 2,197 1,786 2,119 1,432 4.2 40.7 40.7 40.7 40.7 40.7 40.7 40.7 41.2 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 <t< td=""><td>Nigeria</td><td>31</td><td>42</td><td>30</td><td>34</td><td>14</td><td>0.2</td><td>0.2</td><td>0.2</td><td>0.2</td><td>0.1</td></t<></td>	7 7 6 12 4 0.0 Engineering and technology Su/710 28,004 25,442 29,684 30,585 100.0 1 12,486 10,822 9,568 10,833 10,229 40.7 40.7 1,304 1,348 1,213 1,393 1,432 40.7 40.7 1,304 1,348 1,213 1,393 1,432 40.7 40.7 2,596 2,197 1,782 1,991 2,087 8.5 40.7 1,304 1,348 1,213 1,432 4.2 40.7 40.7 2,596 2,197 1,786 2,119 1,432 4.2 40.7 40.7 40.7 40.7 40.7 40.7 40.7 41.2 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 40.7 <t< td=""><td>Nigeria</td><td>31</td><td>42</td><td>30</td><td>34</td><td>14</td><td>0.2</td><td>0.2</td><td>0.2</td><td>0.2</td><td>0.1</td></t<>	Nigeria	31	42	30	34	14	0.2	0.2	0.2	0.2	0.1
29 20 25 41 34 0.2 0.1 0.1 0.2 30,710 28 004 25 442 29,684 30,585 100.0 100.0 100.0 12,486 10,822 9,568 10,833 10,229 40.7 38.6 37.6 36.5 1,304 1,348 1,213 1,322 40.7 38.6 37.6 36.5 1,502 843 961 1,213 1,324 3.3 3.0 4.8 4.7 2,502 2,197 1,786 2,119 1,823 7.6 7.7 7.0 4.7 2,502 2,197 1,786 2,119 1,823 7.6 7.7 7.0 4.7 2,502 2,167 1,786 2,119 1,823 7.6 7.7 7.0 7.1 1,020 843 961 1,02 1,22 7.7 7.0 7.1 2,02 2 2 4 4 4 4	29 20 25 41 34 0.2 Engineering and technology 30,710 28,004 25,442 29,684 30,585 100.0 1 12,486 10,822 9,568 10,833 1,432 4.2 4.2 1,2486 2,197 1,782 1,991 2,087 8.5 4.2	Kenya	7	7	9	12	4	0.0	0.0	0.0	0.1	0.0
Engineering and technology 30,710 28,004 25,442 29,684 30,585 100.0 100.0 100.0 12,486 10,822 9,568 10,833 10,229 40.7 38.6 37.6 36.5 1,248 1,848 1,213 1,393 1,432 4.2 4.8 4.8 4.7 2,596 2,197 1,782 1,393 1,432 4.2 4.8 4.8 4.7 2,596 2,197 1,786 2,119 2,087 8.5 7.8 7.0 6.7 2,592 2,167 1,786 2,119 1,823 7.6 7.7 7.0 6.7 1,020 843 961 1,02 1,2 7.7 7.0 6.7 1,020 843 961 1,2 1,1 1,2 1,1 1,2 1,4 2,0 26 25 42 42 1,2 1,4 0.0 0.0 0.0 0.0 0.0	Engineering and technology 30,710 28,004 25,442 29,684 30,585 100.0 112,486 10,822 9,568 10,833 10,229 40.7 40.7 41.2 42.2	Other S. & C. Africa	29	20	25	4	34	0.2	0.1	0.1	0.2	0.1
30,710 28,004 25,442 29,684 30,585 100.0 100.0 100.0 100.0 12,486 10,822 9,568 10,833 10,229 40.7 38.6 37.6 36.5 1,304 1,348 1,213 1,333 1,432 4.2 4.8 4.8 4.7 1,304 1,348 1,213 1,334 3.0 4.2 4.8 4.7 36.5 1,020 2,197 1,786 2,119 1,334 3.0 4.8 4.7 7.0 6.7 1,020 961 1,213 1,334 3.0 3.0 3.8 4.1 2,322 2,167 1,786 2,119 1,823 7.6 7.7 7.0 7.1 134 108 91 102 123 0.4 0.4 0.4 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 <td< td=""><td>30,710 28,004 25,442 29,684 30,585 100.0 12,486 10,822 9,568 10,833 10,229 40.7 1,304 1,348 1,213 1,393 1,432 4.2 2,596 2,197 1,782 1,991 2,087 8.5 2,596 2,197 1,782 1,991 2,087 8.5 1,020 843 961 1,213 1,354 3.3 2,322 2,167 1,786 2,119 1,823 7.6 2,322 2,167 1,786 2,119 1,823 7.6 134 108 91 102 123 0.0 20 2 2 2 3 0.0 370 311 308 406 426 1.2 428 472 533 669 831 1.4 428 472 54 81 81 0.0 428 60 97 10</td><td></td><td></td><td></td><td>Engine</td><td>ering and tech</td><td>nology</td><td></td><td></td><td></td><td></td><td></td></td<>	30,710 28,004 25,442 29,684 30,585 100.0 12,486 10,822 9,568 10,833 10,229 40.7 1,304 1,348 1,213 1,393 1,432 4.2 2,596 2,197 1,782 1,991 2,087 8.5 2,596 2,197 1,782 1,991 2,087 8.5 1,020 843 961 1,213 1,354 3.3 2,322 2,167 1,786 2,119 1,823 7.6 2,322 2,167 1,786 2,119 1,823 7.6 134 108 91 102 123 0.0 20 2 2 2 3 0.0 370 311 308 406 426 1.2 428 472 533 669 831 1.4 428 472 54 81 81 0.0 428 60 97 10				Engine	ering and tech	nology					
12,486 10,822 9,568 10,833 10,229 40.7 38.6 37.6 1,304 1,348 1,213 1,393 1,432 4.2 4.8 4.8 2,596 2,197 1,782 1,391 2,087 8.5 7.8 7.0 1,020 843 961 1,213 1,354 3.3 3.0 3.8 4.9 4.0	12,486 10,822 9,568 10,833 10,229 40.7 1,304 1,348 1,213 1,393 1,432 4.2 2,596 2,197 1,782 1,991 2,087 8.5 2,596 2,197 1,782 1,991 2,087 8.5 1,020 843 961 1,213 1,354 3.3 1,020 843 961 1,213 1,354 3.3 2,322 2,167 1,786 2,119 1,823 7.6 134 108 91 102 123 0.4 134 108 2,119 1,823 7.6 0.0 20 2 42 40 0.1 0.0 300 0 1 2 42 42 1.2 310 283 190 206 235 1.2 1.4 428 472 533 669 831 1.4 47 49 <td< td=""><td>World</td><td>30,710</td><td>28,004</td><td>25,442</td><td>29,684</td><td>30,585</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td></td<>	World	30,710	28,004	25,442	29,684	30,585	100.0	100.0	100.0	100.0	100.0
1,304 1,348 1,213 1,393 1,432 4.2 4.8 4.8 2,596 2,197 1,782 1,991 2,087 8.5 7.8 7.0 1,020 843 961 1,213 1,354 3.3 3.0 3.8 2,322 2,167 1,786 2,119 1,823 7.6 7.7 7.0 134 108 961 1,213 1,23 0.4 0.4 0.4 134 108 2,119 1,823 7.6 7.7 7.7 7.0 134 108 2,119 1,823 7.6 0.4 0.4 0.4 135 26 25 42 40 0.1 0.1 0.1 0.1 360 283 190 206 235 1.2 1.1 1.2 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.3 118 122 162 183 <	1,304 1,348 1,213 1,393 1,432 4.2 2,596 2,197 1,782 1,991 2,087 8.5 1,020 843 961 1,213 1,354 3.3 2,322 2,167 1,786 2,119 1,823 7.6 134 108 91 102 123 0.4 134 108 91 102 123 0.4 20 26 25 42 40 0.1 20 0 0 0 0 0 0 370 311 308 406 426 1.2 360 283 190 206 235 1.2 360 283 190 206 235 1.2 428 472 533 669 831 1.4 72 139 205 312 376 0.2 118 122 162 183 174 0.4 47 49 86 102 0 0	United States	12,486	10,822	9,568	10,833	10,229	40.7	38.6	37.6	36.5	33.4
2,596 2,197 1,782 1,991 2,087 8.5 7.8 7.0 1,020 843 961 1,213 1,354 3.3 3.0 3.8 1,020 843 961 1,213 1,354 3.3 3.0 3.8 2,322 2,167 1,786 2,119 1,223 7.6 7.7 7.0 134 108 2,119 1,23 0.4 0.4 0.4 0.4 20 2 25 42 3 0.0 0.0 0.0 370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.1 1.2 428 472 533 669 831 1.4 1.7 2.1 428 472 533 669 831 1.4 1.7 2.1 47 49 86 102 0.0 0.0 0.	2,596 2,197 1,782 1,991 2,087 1,020 843 961 1,213 1,354 2,322 2,167 1,786 2,119 1,823 134 108 91 102 123 134 108 91 102 123 175 122 112 143 196 20 26 25 42 40 0 0 0 0 24 360 283 190 206 235 1 0 0 0 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 113 </td <td>Canada</td> <td>1,304</td> <td>1,348</td> <td>1,213</td> <td>1,393</td> <td>1,432</td> <td>4.2</td> <td>4.8</td> <td>4.8</td> <td>4.7</td> <td>4.7</td>	Canada	1,304	1,348	1,213	1,393	1,432	4.2	4.8	4.8	4.7	4.7
1,020 843 961 1,213 1,354 3.3 3.0 3.8 2,322 2,167 1,786 2,119 1,823 7.6 7.7 7.0 134 108 91 102 123 0.4 0.4 0.4 175 122 112 112 143 196 0.6 0.4 0.4 20 26 25 42 40 0.1 0.1 0.1 370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.1 1.2 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.0 0.0 428 472 633 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 26 54 81 81 0.4 0.4 0.6 118 122 162 183 174 0.4 0.4 0.6 10 0 0	1,020 843 961 1,213 1,354 2,322 2,167 1,786 2,119 1,823 134 108 91 102 123 175 122 112 143 196 20 26 25 42 40 0 0 1 2 3 370 311 308 406 426 360 283 190 206 235 1 0 0 0 2 428 472 533 669 831 72 139 205 312 376 12 56 54 81 81 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 11 0 0 0 0 10 0	United Kingdom	2,596	2,197	1,782	1,991	2,087	8.5	7.8	7.0	6.7	8.9
2,322 2,167 1,786 2,119 1,823 7.6 7.7 7.0 134 108 91 102 123 0.4 0.4 0.4 175 122 112 143 196 0.6 0.4 0.4 20 26 25 42 40 0.1 0.1 0.1 370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.0 0.0 428 472 533 669 831 1.4 1.7 2.1 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 428 47 49 86 102 0.0 0.0 0.0 0.0 0.0 47 49 86 102 0.2 0.2 0.2 0.0 0 0 0 0 0 0 <	2,322 2,167 1,786 2,119 1,823 134 108 91 102 123 175 122 112 143 196 20 26 25 42 40 20 26 25 42 40 370 311 308 406 426 360 283 190 206 235 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 118 122 162 183 174 145 86 102 145 160 0 0 0 0	France	1,020	843	961	1,213	1,354	3.3	3.0	3.8	4.1	4.4
134 108 91 102 123 0.4 0.4 0.4 175 122 112 143 196 0.6 0.4 0.4 20 26 25 42 40 0.1 0.1 0.1 370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.1 1.2 428 472 533 669 831 1.4 1.7 2.1 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 118 122 162 183 174 0.4 0.4 0.6 47 49 86 102 145 0.2 0.2 0.3 9 0 0 0 0 0 0 0 0	134 108 91 102 123 175 122 112 143 196 20 26 25 42 40 0 0 1 2 3 370 311 308 406 426 360 283 190 206 235 1 0 0 0 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 47 49 86 102 145 9 0 0 0 0 0 0 0 0	Germany	2,322	2,167	1,786	2,119	1,823	7.6	7.7	7.0	7.1	0.9
175 122 112 143 196 0.6 0.4 0.4 20 26 25 42 40 0.1 0.1 0.1 370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.1 1.2 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 26 54 81 81 0.0 0.1 0.2 0.5 0.8 47 49 86 102 145 0.2 0.2 0.3 0.0	175 122 112 143 196 20 26 25 42 40 0 0 1 2 3 370 311 308 406 426 360 283 190 206 235 1 0 0 0 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 <t< td=""><td>Austria</td><td>134</td><td>108</td><td>91</td><td>102</td><td>123</td><td>0.4</td><td>0.4</td><td>0.4</td><td>0.3</td><td>0.4</td></t<>	Austria	134	108	91	102	123	0.4	0.4	0.4	0.3	0.4
20 26 25 42 40 0.1 0.1 0.1 370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.1 1.2 360 283 190 206 235 1.2 1.1 1.2 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 669 831 1.4 1.7 2.1 0.2 0.5 0.8 12 139 205 312 376 0.2 0.5 0.8 0.8 118 122 162 183 174 0.4 0.4 0.6 0.0 85 60 97 103 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	20 26 25 42 40 0 0 1 2 3 370 311 308 406 426 360 283 190 206 235 1 0 0 0 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 47 49 86 102 145 85 60 97 103 109 0 0 0 0 27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0<	Belgium	175	122	112	143	196	9.0	0.4	0.4	0.5	9.0
0 0 1 2 3 0.0 0.0 0.0 370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.0 0.7 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 6 54 81 81 0.0 0.1 0.2 118 122 162 183 174 0.4 0.4 0.6 47 49 86 102 145 0.2 0.2 0.3 85 60 97 103 109 0.3 0.2 0.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0<	0 0 1 2 3 370 311 308 406 426 360 283 190 206 235 1 0 0 0 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 0 63	Ireland	20	26	25	42	40	0.1	0.1	0.1	0.1	0.1
370 311 308 406 426 1.2 1.1 1.2 360 283 190 206 235 1.2 1.0 0.7 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 66 54 81 81 0.0 0.1 0.2 0.8 118 122 162 183 174 0.4 0.4 0.6 0.3 47 49 86 102 145 0.2 0.2 0.3 0.2 0.3 0.4 0.6 0.0 <td>370 311 308 406 426 360 283 190 206 235 1 0 0 2 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <t< td=""><td>Luxembourg</td><td>0</td><td>0</td><td>-</td><td>7</td><td>ო</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td></t<></td>	370 311 308 406 426 360 283 190 206 235 1 0 0 2 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <t< td=""><td>Luxembourg</td><td>0</td><td>0</td><td>-</td><td>7</td><td>ო</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td></t<>	Luxembourg	0	0	-	7	ო	0.0	0.0	0.0	0.0	0.0
360 283 190 206 235 1.2 1.0 0.7 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 26 54 81 81 0.0 0.1 0.2 118 122 162 183 174 0.4 0.4 0.6 47 49 86 102 145 0.2 0.2 0.3 85 60 97 103 109 0.3 0.2 0.4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <td>360 283 190 206 235 1 0 0 2 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>Netherlands</td> <td>370</td> <td>311</td> <td>308</td> <td>406</td> <td>426</td> <td>1.2</td> <td>[:</td> <td>1.2</td> <td>4.</td> <td>4.1</td>	360 283 190 206 235 1 0 0 2 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Netherlands	370	311	308	406	426	1.2	[:	1.2	4.	4.1
1 0 0 0 0 0 0 0 428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 26 54 81 81 0.0 0.1 0.2 118 122 162 183 174 0.4 0.4 0.6 47 49 86 102 145 0.2 0.2 0.3 85 60 97 103 109 0.3 0.2 0.4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 2 428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 0 3 6	Switzerland	360	283	190	206	235	1.2	1.0	0.7	0.7	0.8
428 472 533 669 831 1.4 1.7 2.1 72 139 205 312 376 0.2 0.5 0.8 12 26 54 81 81 0.0 0.1 0.2 0.8 118 122 162 183 174 0.4 0.4 0.6 0.0 47 49 86 102 145 0.2 0.2 0.3 0.3 0.2 0.3 0.4 0.6 0.0	428 472 533 669 831 72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 27 0 0 0 0 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 0 63	Other W. Europe	-	0	0	0	2	0.0	0.0	0.0	0.0	0.0
72 139 205 312 376 0.2 0.5 0.8 12 26 54 81 81 0.0 0.1 0.2 0.2 118 122 162 183 174 0.4 0.4 0.6 47 49 86 102 145 0.2 0.2 0.3 85 60 97 103 109 0.3 0.2 0.4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 0 3 6 0.0 0 0	72 139 205 312 376 12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 27 0 0 0 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 0 3 6	Italy	428	472	533	699	831	4.	1.7	2.1	2.3	2.7
12 26 54 81 81 0.0 0.1 0.2 118 122 162 183 174 0.4 0.4 0.6 47 49 86 102 145 0.2 0.2 0.3 85 60 97 103 109 0.3 0.2 0.4 0 0 0 0 0 0 0.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 0 3 6 0.0 0	12 26 54 81 81 118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 27 0 0 0 0 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 63 1 3 0 3 6	Spain	72	139	202	312	376	0.2	0.5	8.0	1.1	1.2
118 122 162 183 174 0.4 0.4 0.6 47 49 86 102 145 0.2 0.2 0.3 85 60 97 103 109 0.3 0.2 0.4 9 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 1 3 0 3 6 0 0 0	118 122 162 183 174 47 49 86 102 145 85 60 97 103 109 0 0 0 0 27 0 0 0 0 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 63 1 3 0 3 6	Portugal	12	56	54	81	81	0.0	0.1	0.2	0.3	0.3
47 49 86 102 145 0.2 0.2 0.3 85 60 97 103 109 0.3 0.2 0.4 90 0 0 0 0 0.0 0.0 100 0 0 0 0 0.0 100 0 0 0 0 0.0 100 0 0 0 0 0 100 0 0 0 0 0 100 0 0 0 0 0 100 0 0 0 0 0 100 0 0 0 0 0	47 49 86 102 145 85 60 97 103 109 97 103 109 27 90 0 0 0 19 90 0 0 0 0 0 90 0 0 0 0 0 1 3 0 3 6	Greece	118	122	162	183	174	0.4	9.0	9.0	9.0	9.0
85 60 97 103 0.2 0.4 0 0 0 0 0.0 0.0 0.0 0 0 0 0 0.0 0.0 0.0 0 0 0 0 0.0 0.0 0.0 1 3 0 3 6 0.0 0.0 0.0	85 60 97 103 109 0 0 0 0 27 0 0 0 0 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 63 1 3 0 3 6	Turkey	47	49	98	102	145	0.2	0.2	0.3	0.3	0.5
	0 0 0 27 0 0 0 19 0 0 0 0 0 0 0 0 0 0 0 0 1 3 0 3 6	Yugoslavia (former)	82	09	26	103	109	0.3	0.2	4.0	0.3	0.4
	0 0 0 19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 63 1 3 0 3 6	Slovenia	0	0	0	0	27	0.0	0.0	0.0	0.0	0.1
ant)	ant)	Croatia	0	0	0	0	19	0.0	0.0	0.0	0.0	0.1
ent)	ant)	Bosnia	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
3 0 3 6 0.0 0.0		Yugoslavia (current)	0	0	0	0	63	0.0	0.0	0.0	0.0	0.2
		Other S. Europe	-	က	0	က	9	0.0	0.0	0.0	0.0	0.0

Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Number of		& technical a	scientific & technical articles published in:	in:	Percent	of total scient	ific & technical	Percent of total scientific & technical articles published in:	hed in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Denmark	94	65	81	66	106	0.3	0.2	0.3	0.3	0.3
Sweden	305	255	240	230	322		6.0	0.9	0.8	1:
Norway	70	73	29	101	66	0.2	0.3	0.3	0.3	0.3
Finland	117	106	115	149	168	0.4	0.4	0.5	0.5	0.5
Iceland	2	0	0	က	2	0.0	0.0	0.0	0.0	0.0
Bulgaria	52	43	39	20	63	0.2	0.2	0.2	0.2	0.2
Hungary	88	61	62	46	64	0.3	0.2	0.3	0.2	0.2
Poland	338	295	269	270	292	1.1	1.1	1.1	6.0	1.0
Czechoslovakia (former)	153	117	109	163	164	0.5	0.4	0.4	0.5	0.5
Czech Republic	0	0	0	0	115	0.0	0.0	0.0	0.0	0.4
Slovakia	0	0	0	0	49	0.0	0.0	0.0	0.0	0.2
Other E. Europe	53	22	34	44	65	0.2	0.2	0.1	0.1	0.2
USSR (former)	2,340	1,663	1,239	1,577	1,550	7.6	5.9	4.9	5.3	5.1
Russia	0	0	0	0	1,150	0.0	0.0	0.0	0.0	3.8
Ukraine	0	0	0	0	314	0.0	0.0	0.0	0.0	1.0
Baltic states	0	0	0	0	20	0.0	0.0	0.0	0.0	0.1
Other former USSR	0	0	0	0	99	0.0	0.0	0.0	0.0	0.2
Japan	2,827	3,213	2,580	2,843	3,018	9.2	11.5	10.1	9.6	6.6
China	113	227	292	657	757	0.4	0.8	2.2	2.2	2.5
Taiwan	52	125	342	603	962	0.2	0.4	1.3	2.0	2.6
South Korea	36	109	167	279	515	0.1	0.4	0.7	6.0	1.7
Singapore	23	44	80	109	222	0.1	0.2	0.3	0.4	0.7
Hong Kong	0	0	62	78	150	0.0	0.0	0.2	0.3	0.5
India	954	863	737	887	779	3.1	3.1	2.9	3.0	2.5
Other Asia	73	29	45	22	72	0.2	0.2	0.2	0.2	0.2
Australia	460	470	363	467	582	1.5	1.7	1.4	1.6	1.9
New Zealand	89	62	99	61	89	0.3	0.2	0.3	0.2	0.2
Argentina	43	48	28	61	83	0.1	0.2	0.2	0.2	0.3
Brazil	72	89	77	125	125	0.2	0.2	0.3	0.4	0.4
Chile	10	15	18	13	17	0.0	0.1	0.1	0.0	0.1
Other S. America	21	18	25	22	24	0.1	0.1	0.1	0.1	0.1
Mexico	27	24	35	20	48	0.1	0.1	0.1	0.2	0.2
Other C. America	6	12	6	9	6	0.0	0.0	0.0	0.0	0.0
Israel	293	349	250	270	284	1.0	1.2	1.0	6.0	6.0
Other Near East	104	171	233	165	210	0.3	9.0	6.0	9.0	0.7
Egypt	119	110	126	121	121	0.4	0.4	0.5	0.4	0.4
Other N. Africa	15	18	19	47	37	0.0	0.1	0.1	0.2	0.1
South Africa	143	131	92	109	82	0.5	0.5	0.4	0.4	0.3
Nigeria	42	30	36	15	12	0.1	0.1	0.1	0.1	0.0
Kenya	2	-	0	-	2		0.0	0.0	0.0	0.0
Other S. & C. Africa	22	41	15	16	1	0.1	0.0	0.1	0.1	0.0

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

Region/country 1987 1989		ILION	Number of scientific & technical articles published in.	3		: : 5	-	דפוספון טו נסנמו אסיפוונווס א נפטווווסמו מינוספא אטטוואופט ווו.			
Mathematics 10,34 9,561 9,163 6,902 7,887 100.0 100.0 100.0 39,473 3,669 3,664 3,664 3,664 3,664 3,67 4,81 4,83 3,84	Region/country	1981	1985	1989	1992		1981	1985	1989	1992	1995
(0334) 9,651 9,183 9,322 7,987 1000 1000 1000 1000 (354) 3,669 3,664 3,165 2,811 38.2 38.3 38.3 38.1 (354) 3,669 3,664 3,165 2,811 38.2 38.3 38.3 38.1 (351) 681 685 686 699 840 61 69 57.2 65 <td></td> <td></td> <td></td> <td></td> <td>Mathematics</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>					Mathematics						
3943 3669 3664 3165 2811 382 383 389 389 357 451 654 665 684 685 684 665 684 665 684 685 684 665 684 665 684 685 684 110 76 685 684 110 76 685 684 110 76 685 684 110 76 685 685 584 110 76 685 685 686 <td>World</td> <td>10,334</td> <td>9,551</td> <td>9,193</td> <td>8,302</td> <td>7,987</td> <td>100.0</td> <td>100.0</td> <td>100.0</td> <td>100.0</td> <td>100.0</td>	World	10,334	9,551	9,193	8,302	7,987	100.0	100.0	100.0	100.0	100.0
527 441 501 398 357 51 46 54 134 655 566 537 461 61 65 57 134 782 666 568 546 110 78 66 89 89 70 66 699 840 15 69 75 89 88 70 54 75 09 09 09 75 80 88 70 54 75 09 05 09 75 66 00	United States	3,943	3,659	3,664	3,165	2,811	38.2	38.3	39.9	38.1	35.2
631 665 526 637 461 61 65 57 1,134 781 661 686 689 840 56 69 57 56 89 87 79 68 49 51 08 57 56 75 69 75 66 75 75 60 75 60 75 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 75 60 70	Canada	527	441	501	398	357	5.1	4.6	5.4	4.8	4.5
541 661 686 689 840 56 67 1,134 752 66 689 84 110 72 66 89 78 75 66 75 66 75 66 75 66 75 66 75 66 75 66 75 66 75 66 75 66 75 66 75 66 75 66 75 76 70	United Kingdom	631	655	526	537	461	6.1	6.9	5.7	6.5	5.8
1144 752 606 558 546 110 79 66 80 73 68 49 51 08 0.8 0.7 68 79 68 79 68 79 69 0.9 0.0 0.	France	581	661	989	669	840	5.6	6.9	7.5	8.4	10.5
80 79 68 49 51 0.8 0.7 80 88 70 54 75 0.9 0.9 0.9 80 15 15 15 16 0.0 0.0 0.0 0.0 10 10 1 1 1 1 1 1 1 0.0 0.	Germany	1,134	752	909	558	546	11.0	7.9	9.9	6.7	6.8
89 88 70 54 75 0.9 0.9 0.8 142 145 146 146 148 14 145 0.0	Austria	80	6/	89	49	51	0.8	0.8	0.7		9.0
26 15 23 15 18 0.3 0.2 0.3 0.0	Belgium	88	88	70	54	75	0.9	0.9	0.8		0.9
142 147 149 146 158 14 15 16 72 66 72 56 79 0.0	Ireland	56	15	23	15	18	0.3	0.2	0.3		0.2
142 147 149 146 128 1.4 1.5 1.6 72 66 72 56 79 0.7 0.7 0.8 138 224 293 234 286 1.3 2.3 0.7 0.8 40 122 175 162 208 0.4 1.3 1.9 1.9 50 56 56 52 43 41 0.5 0.0 <td>Luxembourg</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td></td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td>	Luxembourg	0	0	0	0	0		0.0	0.0	0.0	0.0
72 66 72 56 79 0.7 0.7 0.8 138 224 284 286 1.3 2.3 3.2 40 122 175 162 2.8 0.4 1.3 1.3 50 55 55 52 43 41 0.5 0.0 0.0 6 56 55 52 43 41 0.5 0.0	Netherlands	142	147	149	146	128	4.1	1.5	1.6	1.8	1.6
0 0	Switzerland	72	99	72	26	79	0.7	0.7	0.8	0.7	1.0
138 224 293 234 286 1.3 2.3 3.2 40 122 175 162 208 0.4 1.3 1.9 50 55 52 43 41 0.5 0.6 0.0 11 11 11 11 11 0.1 0.1 0.0 26 27 37 34 25 0.3 0.3 0.4 0<	Other W. Europe	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
40 122 175 162 208 0.4 1.3 1.9 50 55 43 41 0.5 0.6 0.6 0.0	Italy	138	224	293	234	286	1.3	2.3	3.2	2.8	3.6
10 17 20 16 23 0.1 0.2 0.2 11 11 11 11 11 11 11 0.5 0.6 0.6 26 27 37 34 25 0.3 0.3 0.0 26 27 37 34 25 0.0	Spain	40	122	175	162	208	0.4	1.3	1.9	2.0	2.6
50 55 52 43 41 0.5 0.6 0.6 11 11 11 10 11 11 10 11 0.0 0	Portugal	10	17	20	16	23	0.1	0.2	0.2	0.2	0.3
11 11 11 11 10 11 11 10 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 0.1	Greece	20	22	52	43	41	0.5	9.0	9.0	0.5	0.5
26 27 37 34 25 0.3 0.3 0.4 0 <t< td=""><td>Turkey</td><td>1</td><td>=</td><td>10</td><td>1</td><td>13</td><td>0.1</td><td>0.1</td><td>0.1</td><td>0.1</td><td>0.2</td></t<>	Turkey	1	=	10	1	13	0.1	0.1	0.1	0.1	0.2
0 0 0 12 0.0 0.0 0.0 0<	Yugoslavia (former)	56	27	37	34	25	0.3	0.3	0.4	4.0	0.3
0 0	Slovenia	0	0	0	0	12	0.0	0.0	0.0	0.0	0.2
0 0	Croatia	0	0	0	0	80	0.0	0.0	0.0	0.0	0.1
0 0	Bosnia	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
0 0 0 1 1 0.0 0.0 74 54 56 50 57 0.7 0.6 0.0 81 72 63 54 85 0.8 0.8 0.0 33 44 39 29 34 0.3 0.5 0.4 57 44 44 38 30 0.6 0.5 0.5 4 2 0 3 3 0.0 0.0 0.0 33 31 34 25 25 0.3 0.0 0.0 99 146 94 64 42 1.0 1.5 1.0 95 168 151 106 94 0.9 1.8 1.6 43 41 49 70 51 0.4 0.4 0.5 90 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0 </td <td>Yugoslavia (current)</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>2</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.1</td>	Yugoslavia (current)	0	0	0	0	2	0.0	0.0	0.0	0.0	0.1
74 54 56 50 57 0.7 0.6 0.6 81 72 63 54 85 0.8 0.8 0.7 33 44 39 29 34 0.3 0.5 0.4 57 44 44 38 30 0.6 0.5 0.5 4 2 0 3 3 0.0 0.0 0.0 33 31 34 25 25 0.3 0.3 0.4 99 146 94 64 42 1.0 1.5 1.0 95 168 151 1.06 94 0.9 1.8 1.6 43 41 49 70 51 0.4 0.4 0.5 90 0 0 0 0 0 0 0 0 0 90 1 0 0 0 0 0 0 0 0 </td <td>Other S. Europe</td> <td>0</td> <td>0</td> <td>0</td> <td>-</td> <td>-</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td>	Other S. Europe	0	0	0	-	-	0.0	0.0	0.0	0.0	0.0
81 72 63 54 85 0.8 0.8 0.7 33 44 39 29 34 0.3 0.5 0.4 4 2 0 3 3 0.0 0.0 0.0 33 31 34 25 25 0.3 0.0 0.0 99 146 94 64 42 1.0 1.5 1.0 43 41 49 70 51 0.4 0.4 0.5 0 0 0 0 0 0 0.0 0.0 0.0 10 0 0 0 0 0 0 0.0 0.0 10 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0 0 0 0 10 0<	Denmark	74	54	26	20	22	0.7	9.0	9.0	9.0	0.7
33 44 39 29 34 0.3 0.5 0.4 57 44 44 38 30 0.6 0.5 0.5 0.5 33 31 34 25 25 0.3 0.0 0.0 0.0 99 146 94 64 42 1.0 1.5 1.0 43 41 49 70 51 0.4 0.4 0.5 0 0 0 0 0 0 0.0 0.0 0.0 151 50 41 49 70 51 0.4 0.4 0.5 0 0 0 0 0 0 0 0 0 0 151 50 41 33 32 0.5 0.5 0.0 152 51 50 41 33 32 0.5 0.5 152 51 50 0 0 0 0 0 0 153 52 53 0.0 0 0 0 0 0 154 275 296 412 236 0.6 0 0 0 173 <t< td=""><td>Sweden</td><td>81</td><td>72</td><td>63</td><td>54</td><td>82</td><td>0.8</td><td>0.8</td><td>0.7</td><td>0.7</td><td>1.1</td></t<>	Sweden	81	72	63	54	82	0.8	0.8	0.7	0.7	1.1
57 44 44 38 30 0.6 0.5 0.5 4 2 0 3 3 0.0 0.0 0.0 33 31 34 25 25 0.3 0.3 0.4 99 146 94 64 42 1.0 1.5 1.0 43 41 49 70 51 0.4 0.4 0.5 0 0 0 0 28 0.0 0.0 0.0 0 0 0 0 0 0 0.0 0.0 51 50 41 33 32 0.5 0.5 0.4 784 275 296 412 236 7.6 2.9 3.2 0 0 0 0 0 0 0 0 0	Norway	33	44	39	59	34	0.3	0.5	4.0	0.3	0.4
4 2 0 3 3 0.0 0.0 0.0 33 31 34 25 25 0.3 0.3 0.4 99 146 94 64 42 1.0 1.5 1.0 43 41 49 70 51 0.4 0.4 0.5 0 0 0 0 28 0.0 0.0 0.0 0 0 0 0 0 0.0 0.0 51 50 41 33 32 0.5 0.5 784 275 296 412 236 7.6 2.9 3.2 0 0 0 0 0 0.0 0.0 0.0	Finland	22	44	44	38	30	9.0	0.5	0.5	0.5	0.4
33 31 34 25 25 0.3 0.3 0.4 99 146 94 64 42 1.0 1.5 1.0 43 41 49 70 51 0.4 0.4 0.5 0 0 0 0 28 0.0 0.0 0.0 0 0 0 0 0 0.0 0.0 51 50 41 33 32 0.5 0.4 784 275 296 412 236 7.6 2.9 3.2 10 0 0 0 0 0.0 0.0 0.0	Iceland	4	2	0	က	က	0.0	0.0	0.0	0.0	0.0
99 146 94 64 42 1.0 1.5 1.0 95 168 151 106 94 0.9 1.8 1.6 10 15 10 16 16 1.8 1.6 11 10 1 1 1 1 11 10 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Bulgaria	33	31	34	25	25	0.3	0.3	4.0	0.3	0.3
95 168 151 106 94 0.9 1.8 1.6 43 41 49 70 51 0.4 0.4 0.5 0 0 0 0 28 0.0 0.0 0.0 0 0 0 0 0 0 0.0 0.0 51 50 41 33 32 0.5 0.5 0.4 784 275 296 412 236 7.6 2.9 3.2 0 0 0 0 0 0 0.0 0.0	Hungary	66	146	94	64	42	1.0	1.5	1.0	0.8	0.5
43 41 49 70 51 0.4 0.4 0.5 0 0 0 28 0.0 0.0 0.0 0 0 0 0 0 0.0 0.0 51 50 41 33 32 0.5 0.5 0.4 784 275 296 412 236 7.6 2.9 3.2 0 0 0 0 0 0.0 0.0 0.0	Poland	92	168	151	106	94	6.0	1.8	1.6	1.3	1.2
0 0 0 28 0.0 0.0 0.0 0 0 0 23 0.0 0.0 0.0 51 50 41 33 32 0.5 0.5 0.4 784 275 296 412 236 7.6 2.9 3.2 0 0 0 0 0 0 0 0	Czechoslovakia (former)	43	4	49	20	51	0.4	0.4	0.5	0.8	9.0
0 0 0 0 23 0.0 0.0 0.0 0 51 50 41 33 32 0.5 0.5 0.4 0 784 275 296 412 236 7.6 2.9 3.2 5 0 0 0 0 0 0 0 0 0	Czech Republic	0	0	0	0	28	0.0	0.0	0.0	0.0	0.4
51 50 41 33 32 0.5 0.5 0.4 0 784 275 296 412 236 7.6 2.9 3.2 5 0 0 0 0 173 0.0 0.0 0.0 0	Slovakia	0	0	0	0	23	0.0	0.0	0.0	0.0	0.3
784 275 296 412 236 7.6 2.9 3.2 5. 0 0 0 0 173 0.0 0.0 0.0	Other E. Europe	51	20	41	33	32	0.5	0.5	0.4	0.4	0.4
0 0 0 0 173 0.0 0.0 0.0 0.0	USSR (former)	784	275	296	412	236	7.6		3.2		3.0
	Russia	0	0	0	0	173	0.0		0.0		2.2

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Appendix table 5-49. Scientific and technical articles, by country and field: 1981-95, selected years

	Num	Number of scientific & technical articles published in:	& technical ar	ticles publishe	d in:	Percen	of total scienti	Percent of total scientific & technical articles published in:	articles publish	ed in:
Region/country	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
Ukraine	0	0	0	0	29	0.0	0:0	0.0	0.0	0.4
Baltic states	0	0	0	0	2	0.0	0.0	0.0	0.0	0.0
Other former USSR	0	0	0	0	32	0.0	0.0	0.0	0.0	0.4
Japan	449	495	395	292	267	4.3	5.2	4.3	3.5	3.3
China	32	29	123	195	252	0.3	0.7	1.3	2.3	3.2
Taiwan	29	38	39	45	22	0.3	0.4	0.4	0.5	0.7
South Korea	9	15	38	27	39	0.1	0.2	0.4	0.3	0.5
Singapore	œ	19	14	21	40	0.1	0.2	0.2	0.3	0.5
Hong Kong	0	0	22	22	29	0.0	0.0	0.2	0.3	0.4
India	346	300	126	92	79	3.3	3.1	4.1	1.1	1.0
Other Asia	25	34	28	26	27	0.2	0.4	0.3	0.3	0.3
Australia	200	193	173	138	139	1.9	2.0	1.9	1.7	1.7
New Zealand	27	28	25	27	28	0.3	0.3	0.3	0.3	0.4
Argentina	Ξ	15	16	28	16	0.1	0.2	0.2	0.3	0.2
Brazil	46	52	64	20	89	0.4	0.5	0.7	0.8	6.0
Chile	9	15	17	4	18	0.1	0.2	0.2	0.2	0.2
Other S. America	10	12	14	17	23	0.1	0.1	0.2	0.2	0.3
Mexico	10	14	18	22	18	0.1	0.1	0.2	0.3	0.2
Other C. America	9	9	2	4	9	0.1	0.1	0.0	0.0	0.1
Israel	151	154	139	123	142	1.5	1.6	1.5	1.5	1.8
Other Near East	36	41	40	23	24	0.3	0.4	0.4	0.3	0.3
Egypt	15	15	80	15	=	0.1	0.2	0.1	0.2	0.1
Other N. Africa	18	19	17	15	21	0.2	0.2	0.2	0.2	0.3
South Africa	38	42	34	26	28	0.4	0.4	0.4	0.3	0.4
Nigeria	10	19	7	9	2	0.1	0.2	0.1	0.1	0.1
Kenya	4	က	4	0	-	0.0	0.0	0.0	0.0	0.0
Other S. & C. Africa	7	15	16	4	∞	0.1	0.2	0.2	0.0	0.1

NOTE: Data for Hong Kong are included with the United Kingdom through 1986. Details may not add to totals because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

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See figures 5-24 and 5-25.

Appendix table 5-50. Scientific and technical article output of selected countries compared to gross domestic product: 1995

Country	Number of articles	GDP (billions of U.S. \$)	Articles/ GDP (billions of U.S. \$)
Israel	4,322	80	54
Sweden	7,190	177	41
Switzerland	5,896	159	37
Finland	3,246	92	35
Denmark	3,513	113	31
Netherlands	9,239	302	31
New Zealand	1,830	62	29
United Kingdom	32,980	1,138	29
Canada	17,359	694	25
Australia	9,747	405	24
Iceland	117	5	23
		39	22
Slovakia	854 434	39 20	22
Croatia			
Russia	17,180	796	22
Yugoslavia (current)	442	21	21
Germany	30,654	1,452	21
Norway	2,180	106	21
France	23,811	1,173	20
Belgium	3,996	197	20
Hungary	1,469	73	20
United States	142,792	7,248	20
Austria	2,807	152	18
Bulgaria	779	43	18
Poland	3,895	227	17
Ireland	900	55	16
Greece	1,639	102	16
Spain	8,811	565	16
Slovenia	339	23	15
Czech Republic	1,577	106	15
Japan	39,498	2,679	15
Ukraine	2,489	175	14
	•	66	13
Singapore	891		
Taiwan	3,884	291	13
Italy	14,117	1,089	13
South Africa	1,744	215	8
Hong Kong	1,091	152	7
Kenya	253	37	7
Egypt	1,136	171	7
Portugal	764	116	7
Chile	700	113	6
Argentina	1,581	279	6
India	7,851	1,409	6
South Korea	2,964	591	5
Bosnia	5	1	5
Turkey	1,359	346	4
Brazil	2,760	977	3
Nigeria	342	136	3
Luxembourg	20	10	2
Mexico	1,408	721	2
IVIEXICO			

SOURCES: **World GDP data**—U.S. Central Intelligence Agency, World Fact Book <<ht>thtp://www.odci.gov/cia/publications/nsolo/wbf-eco.htm>> (September 1997); **publications data**—Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

See figure 5-26.

Appendix table 5-51. Distribution of scientific and technical articles for selected countries, by field: 1981-95, selected years (Percentages)

		Artio	cles publishe	ed in:			Artic	les publishe	d in:	
Field	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
			World				ι	Jnited State	s	
Clinical medicine	31.5	32.2	32.2	31.5	30.7	36.3	36.7	35.9	35.2	35.3
Biomedical research	15.0	16.6	17.0	16.8	16.4	16.5	17.8	18.8	19.4	19.7
Biology	10.6	9.0	8.5	8.1	8.0	11.1	9.5	9.0	8.4	7.8
Chemistry	14.8	14.2	13.9	14.0	14.0	8.2	8.4	8.8	9.0	9.0
Physics	12.3	13.9	15.2	15.7	16.9	9.9	11.5	12.5	12.5	12.5
Earth &										
space sciences	4.6	4.6	4.6	4.9	5.3	5.5	5.6	5.5	5.8	6.6
Engineering										
& technology	8.3	7.2	6.3	7.0	7.0	9.4	7.9	6.8	7.6	7.2
Mathematics	2.8	2.4	2.3	2.0	1.8	3.0	2.7	2.6	2.2	2.0
			Canada					nited Kingdo		
Olinia al manadiaina	07.7	00.0		00.0	00.0	00.0				00.0
Clinical medicine	27.7	28.9	30.1	30.3	29.2	36.9	41.0	42.4	41.0	38.3
Biomedical research	15.6	15.9	16.7	17.1	17.1	15.3	16.4	16.5	16.9	17.5
Biology	17.0	17.3	16.3	15.2	13.8	11.4	9.6	8.7	7.9	8.1
Chemistry	11.6	10.4	9.6	9.9	10.4	11.7	10.2	10.3	10.6	10.8
Physics	9.2	10.4	9.7	10.0	10.6	9.4	9.4	10.0	10.8	12.0
Earth &	0.4	0.4	7.0	- -	0.0		4.0	4.0	4.0	
space sciences	6.1	6.4	7.6	7.5	8.6	4.7	4.6	4.6	4.9	5.6
Engineering										
& technology	9.0	8.1	7.0	7.8	8.2	8.4	6.8	5.8	6.3	6.3
Mathematics	3.6	2.6	2.9	2.2	2.1	2.0	2.0	1.7	1.7	1.4
			France					Germany		
Clinical medicine	32.7	29.1	29.7	29.2	28.4	30.5	29.9	30.1	30.4	28.4
Biomedical research	15.5	17.6	17.3	17.6	16.9	14.6	14.5	15.9	14.9	14.9
Biology	7.4	6.2	5.9	6.2	5.8	8.8	6.9	6.6	5.6	6.0
Chemistry	17.2	17.7	16.4	16.1	15.4	17.1	18.8	17.8	17.2	17.9
Physics	14.4	17.5	18.2	17.8	19.2	13.0	15.8	17.7	19.1	21.2
Earth &										
space sciences	4.2	3.7	4.2	4.3	5.1	3.1	3.3	3.1	3.6	3.9
Engineering										
& technology	5.5	4.6	4.9	5.6	5.7	8.7	7.9	6.5	7.3	5.9
Mathematics	3.1	3.6	3.5	3.2	3.5	4.2	2.8	2.2	1.9	1.8
			Netherlands					Switzerland		
Clinical medicine	31.9	38.4	40.6	38.2	40.0	40.1	37.5	39.3	37.5	35.1
Biomedical research	18.5	18.5	17.3	18.4	17.5	14.1	16.7	17.2	18.0	17.6
Biology	10.2	8.6	8.6	8.6	9.6	4.9	4.4	4.7	4.6	5.2
	13.9	10.7	10.7	10.6	9.5	13.6	13.7	12.2	13.1	12.8
Chemistry		12.3	12.6	13.0	12.5			18.3	18.6	20.1
Physics Earth &	13.4	12.3	12.0	13.0	12.5	15.3	17.9	10.3	10.0	20.1
	3.6	5.0	4.5	4.7	5.0	2.9	2.7	2.7	3.3	3.9
space sciences	3.0	5.0	4.5	4.7	5.0	2.9	2.1	2.1	3.3	3.9
Engineering	6.2	4.4	3.8	4.8	4.6	7.5	5.8	4.0	3.8	4.0
& technology						I .				
Mathematics	2.4	2.1	1.9	1.7	1.4	1.5	1.3	1.5	1.0	1.3
			r Western E			1		Sweden		
Clinical medicine	43.1	41.5	43.9	42.7	39.5	52.7	54.0	49.9	48.0	44.0
Biomedical research	12.8	14.6	15.8	15.9	15.7	17.6	17.5	18.7	18.0	17.0
Biology	8.5	9.2	7.3	5.8	6.6	6.4	5.5	7.2	7.9	8.0
Chemistry	13.3	12.8	11.6	12.7	12.3	8.6	7.6	7.8	8.8	8.9
Physics	10.9	11.6	12.4	13.4	15.6	6.2	7.5	8.6	9.4	12.4
Earth &										
space sciences	2.9	3.4	2.8	3.3	3.7	2.1	3.1	3.4	3.7	4.0
						1				
Engineering										
•	5.3	4.1	3.7	4.3	4.7	5.2	3.8	3.5	3.4	4.5

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Appendix table 5-51. Distribution of scientific and technical articles for selected countries, by field: 1981-95, selected years (Percentages)

		Artic	cles publishe	ed in:			Artic	les publishe	d in:	
Field	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
		Othe	r Northern I	Europe				Italy		
Clinical medicine	51.5	53.4	52.5	47.4	44.5	34.8	38.5	37.7	37.4	35.1
Biomedical research	14.7	15.2	15.7	16.3	15.1	14.2	14.7	14.3	14.3	14.4
Biology	8.9	8.0	8.2	9.8	10.3	5.8	3.7	4.0	4.5	4.7
Chemistry	7.7	7.0	6.7	6.8	8.3	18.7	16.2	15.2	14.7	13.7
Physics	7.8	7.1	7.6	8.9	10.0	14.7	16.1	17.0	17.3	19.5
Earth &										
space sciences	3.2	4.3	4.0	5.1	6.2	4.5	3.4	4.1	4.6	4.7
Engineering										
& technology	3.9	3.1	3.4	4.2	4.1	5.5	5.0	5.0	5.4	5.9
Mathematics	2.3	1.8	1.8	1.4	1.4	1.8	2.4	2.7	1.9	2.0
			Spain					Southern E	Furone	
OII : 1 II :	04.7	100	-	05.0	25.4	00.4			<u>-</u>	
Clinical medicine	21.7	18.0	22.6	25.2	25.4	26.1	21.3	23.7	26.8	28.3
Biomedical research	20.7	18.6	18.7	15.7	15.4	13.0	11.2	10.2	9.6	9.4
Biology	10.8	6.6	9.3	11.7	11.3	5.9	7.2	7.1	7.2	7.5
Chemistry	28.7	35.1	24.5	23.2	21.6	16.3	20.1	20.4	20.1	19.9
Physics	11.0	13.3	13.6	13.7	15.2	16.4	18.7	17.0	16.7	16.4
Earth &										
space sciences	2.3	1.8	4.2	4.3	4.6	5.4	6.1	6.2	6.3	6.2
Engineering										
& technology	3.0	3.5	3.8	4.1	4.3	12.4	10.8	11.9	10.8	10.2
Mathematics	1.7	3.0	3.2	2.1	2.4	4.6	4.6	3.5	2.4	2.0
		E	astern Euro	pe				Russia		
Clinical medicine	19.2	16.2	14.5	14.2	12.5	12.0	12.3	7.8	5.3	28.3
Biomedical research	15.6	16.9	16.8	15.1	10.5	18.5	17.3	15.8	14.0	9.4
Biology	9.5	7.4	4.9	5.3	5.0	3.1	2.7	3.0	4.6	7.5
Chemistry	29.9	30.8	31.4	31.4	33.0	27.9	27.2	27.6	27.9	19.9
Physics	14.5	16.7	20.7	21.6	26.0	27.8	31.2	33.0	35.5	16.4
Earth &										
space sciences	2.3	2.3	2.2	2.9	3.2	4.2	4.3	5.7	4.9	6.2
Engineering										
& technology	6.2	5.5	5.5	6.3	7.1	5.5	4.1	5.6	6.7	10.2
Mathematics	2.9	4.2	3.9	3.3	2.7	0.9	1.0	1.5	1.0	2.0
			Japan					China		
Clinical medicine	00.5	06 F	-	20.0	20.0	111	140		10.0	0.0
	23.5 13.7	26.5 14.6	29.1 15.8	30.0 15.6	29.0 15.5	14.4 4.5	14.8 9.2	11.8 7.8	10.3 7.8	8.0 7.5
Biomedical research										
Biology	9.6 23.6	8.3 19.9	7.2 18.0	6.8 17.7	6.6 16.9	16.2 8.1	8.0 9.5	3.6 15.1	3.8 19.6	3.6 23.6
Chemistry	23.6 14.9	16.1	18.6	17.7	21.2	21.9	9.5 29.5	39.5	38.0	23.6 37.9
Physics Earth &	14.3	10.1	10.0	13.4	۷۱.۷	۷۱.۶	23.0	J J .J	30.0	31.9
space sciences	1.6	2.0	2.2	2.0	2.5	21.8	13.8	3.8	3.2	3.2
Engineering	1.0	2.0	2.2	2.0	2.5	21.0	13.0	3.0	3.2	3.2
& technology	11.3	10.8	7.9	7.6	7.6	10.2	11.7	15.1	13.4	12.2
Mathematics	1.8	1.7	1.2	0.8	0.7	10.3 2.9	3.4	3.3	4.0	4.1
wathernaucs						2.9			4.0	4.1
			ndustrializii		es			ndia		
Clinical medicine	19.7	20.0	25.1	23.1	20.5	12.9	12.4	12.5	14.0	12.2
Biomedical research	7.6	7.9	9.4	9.4	8.6	13.7	16.9	15.7	12.1	13.3
Biology	12.1	7.1	6.7	5.5	5.0	16.4	8.9	9.2	8.6	7.3
Chemistry	21.2	20.7	19.6	20.7	20.3	27.2	27.9	30.0	28.4	30.3
Physics	13.6	17.1	15.2	17.6	22.2	14.6	16.5	17.7	19.4	21.2
Earth &										
space sciences	3.0	2.1	1.8	2.2	2.6	4.1	5.3	4.6	5.9	4.8
Engineering										
& technology	16.7	20.0	19.0	19.6	19.0	8.1	9.0	8.7	10.5	9.9
Mathematics	6.1	5.0	3.2	2.2	1.9	3.0	3.1	1.5	1.1	1.0

Appendix table 5-51. Distribution of scientific and technical articles for selected countries, by field: 1981-95, selected years (Percentages)

		Artio	cles publishe	ed in:			Artic	les publishe	d in:	
Field	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
		Oth	er Asian nat	tions			Austra	lia & New Z	ealand	
Clinical medicine	27.4	27.9	29.1	29.1	28.1	31.1	33.6	35.1	34.6	33.9
Biomedical research	10.7	12.6	12.0	11.3	10.6	12.3	14.4	14.5	14.9	13.9
Biology	28.6	24.6	25.2	26.2	23.7	23.8	21.4	21.3	20.9	20.1
Chemistry	9.8	11.9	12.5	13.9	16.8	11.0	8.9	8.8	8.6	9.0
Physics	9.4	9.3	9.3	9.2	8.8	7.0	7.5	6.7	7.3	9.2
Earth &										
space sciences	3.6	4.0	5.2	3.4	4.9	7.0	6.7	7.3	7.2	6.8
Engineering										
& technology	7.9	6.2	4.1	4.7	5.2	5.6	5.3	4.2	5.0	5.6
Mathematics	2.7	3.6	2.6	2.2	1.9	2.3	2.2	2.0	1.6	1.4
			Mexico					Argentina		
Clinical medicine	45.2	33.4	32.0	23.7	19.2	30.3	25.9	25.0	25.1	24.1
Biomedical research	11.6	15.3	14.8	16.6	16.0	20.4	21.7	16.9	15.1	16.7
Biology	7.6	11.8	13.2	16.9	16.1	12.1	10.3	11.5	13.8	14.3
Chemistry	9.1	9.1	9.9	11.0	13.6	15.1	18.0	17.0	17.3	14.7
Physics	15.7	20.1	17.3	18.3	22.9	12.7	15.8	19.7	17.6	19.5
Earth &										
space sciences	5.1	5.3	6.7	6.1	7.5	3.4	3.0	4.4	4.0	4.4
Engineering										
& technology	4.2	3.2	4.0	5.1	3.4	4.8	4.0	4.4	4.8	5.2
Mathematics	1.5	1.9	2.1	2.2	1.3	1.2	1.3	1.2	2.2	1.0
			Brazil					Chile		
Clinical medicine	21.2	20.3	18.5	25.2	22.9	44.7	42.4	43.7	44.2	41.3
Biomedical research	18.5	22.7	24.8	17.9	18.0	20.0	12.0	16.5	13.3	14.1
Biology	14.3	10.2	8.5	8.9	9.6	10.9	12.3	10.8	9.7	11.7
Chemistry	12.5	10.6	9.5	9.8	12.1	10.7	13.7	12.7	13.4	10.7
Physics	19.4	23.3	24.5	24.1	25.4	2.5	7.4	5.4	6.1	8.1
Earth &										
space sciences	5.9	4.8	6.2	6.4	5.1	8.4	7.0	5.4	9.5	9.0
Engineering										
& technology	5.0	4.6	4.4	4.9	4.5	1.8	2.6	2.9	1.9	2.4
Mathematics	3.2	3.5	3.6	2.8	2.5	1.1	2.6	2.7	2.0	2.6
<u></u>			ntral & Sout		2.0			Israel		
Clinical medicine	30.2	32.4	29.6	28.9	26.5	34.7	38.8	37.9	38.0	34.1
	30.2 17.3	32.4 15.8	29.6 14.5	16.2	26.5 14.9	15.0	36.6 15.2	15.0	16.1	14.9
Biomedical research	17.3 25.2	22.4	14.5 24.6	22.5	22.1	11.9	9.6	10.5	9.5	9.0
Biology									9.5 7.1	9.0 7.5
Chemistry	11.6	10.0 9.2	10.3	10.5	12.7	9.3	8.8	8.5 14.7		7.5 20.5
Physics	7.1	9.2	11.1	12.6	14.1	13.6	12.4	14.7	15.4	20.5
Earth &	2.0	2.0	2.4	4.0	2 5	2.5	0.0	2.6	4.0	4 4
space sciences	3.0	3.2	3.4	4.0	3.5	3.5	3.3	3.6	4.0	4.1
Engineering	0.6	A A	<i>A</i> F	0.4	0.0	7.0	0.0	6.0	6.0	6.0
& technology	3.6	4.4	4.5	3.1	3.3	7.9	8.2	6.3	6.8	6.6
Mathematics	1.9	2.6	2.1	2.3	2.9	4.1	3.6	3.5	3.1	3.3
			ther Near Ea					Egypt		
Clinical medicine	30.8	30.9	31.9	39.0	36.0	17.8	15.1	13.3	15.2	15.0
Biomedical research	8.8	9.7	6.8	6.3	6.5	9.8	4.8	6.0	5.9	6.5
Biology	13.7	9.4	10.2	10.5	8.7	13.8	12.0	11.3	10.3	8.9
Chemistry	15.7	16.7	18.1	14.3	16.5	36.1	42.7	42.5	38.7	38.7
Physics	8.7	8.5	7.4	7.5	10.9	8.0	8.9	10.6	13.1	15.6
C										
Earth &					4.0	1.0	3.1	4.3	4.6	3.7
space sciences	4.3	4.7	5.9	6.0	4.8	1.8	5.1	4.5	4.0	5.1
	4.3	4.7	5.9	6.0	4.8	1.0	0.1	4.5	4.0	3.7
space sciences	4.3 13.5	4.7 16.1	5.9 16.8	14.3	4.8 14.9	11.2	11.9	11.3	11.0	10.7

Appendix table 5-51. **Distribution of scientific and technical articles for selected countries, by field: 1981-95, selected years** (Percentages)

		Artio	les publishe	ed in:			Artic	les publishe	d in:	
Field	1981	1985	1989	1992	1995	1981	1985	1989	1992	1995
		Oth	er North Af	rica			;	South Africa	3	
Clinical medicine	29.1	23.9	22.5	20.4	20.7	42.1	40.0	34.4	30.7	27.9
Biomedical research	8.0	8.5	5.7	6.7	7.4	8.6	12.7	16.2	14.4	14.2
Biology	9.7	12.0	11.4	8.8	7.6	16.6	16.2	18.0	18.3	20.6
Chemistry	22.8	23.1	31.5	29.7	29.6	11.3	9.5	10.4	11.2	10.9
Physics	13.1	12.8	14.4	14.5	19.1	5.2	5.1	6.4	7.7	6.9
Earth &										
space sciences	3.4	3.8	2.3	3.9	3.8	5.9	7.9	8.6	10.7	13.1
Engineering										
& technology	6.3	7.7	6.4	12.1	7.4	8.0	6.5	4.3	5.6	4.7
Mathematics	7.6	8.1	5.7	3.9	4.2	2.1	2.1	1.6	1.3	1.6
		Other Co	entral & Sou	ıth Africa						
Clinical medicine	40.8	45.5	46.6	47.0	47.7					
Biomedical research	8.9	10.8	11.2	9.7	10.2					
Biology	31.8	27.0	25.5	26.7	27.1					
Chemistry	7.0	5.5	5.8	5.8	4.4					
Physics	2.4	1.9	2.1	2.4	3.7					
Earth &										
space sciences	3.9	4.2	3.8	5.8	3.8					
Engineering										
& technology	4.0	2.7	3.2	2.1	2.0					
Mathematics	1.2	2.3	1.7	0.7	1.0					

NOTE: Details may not add to totals because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation; unpublished tabulations.

See figure 5-27 and text table 5-12.

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 $^{^{\}mathrm{a}}\mathrm{Data}$ are for the former USSR except for 1995.

^bData for Hong Kong are included with United Kingdom through 1986.

Appendix table 5-52. Coauthored and internationally coauthored scientific and technical articles for selected countries: 1981 and 1995

	All a	rticles ^a		or articles of total)	Internationall (percent of	y coauthored f coauthored)
Country	1981	1995	1981	1995	1981	1995
World ^b	368,934	438,767	33	50	17	29
United States	132,278	142,792	43	58	18	32
Canada	14,440	17,359	40	59	43	52
United Kingdom	30,794	32,980	32	55	42	53
France	18,567	23,811	44	64	35	53
Germany	26,837	30,654	31	54	45	61
Austria	2,160	2,807	39	65	45	64
Belgium	3,309	3,996	42	67	52	68
Ireland	700	900	39	61	50	66
Netherlands	5,993	9,239	35	65	48	54
Switzerland	4,801	5,896	40	63	67	76
Italy	7,803	14,117	51	71	32	49
Portugal	184	764	50	70	64	72
Spain	2,362	8,811	34	57	35	55
Greece	793	1,639	35	62	58	62
	251	,	44	56	69	46
Turkey Denmark	3,198	1,359	50	69	42	63
	,	3,513				
Sweden	5,846	7,190	50	66	36	59
Norway	1,920	2,180	44	68	40	58
Finland	2,173	3,246	48	70	33	50
Bulgaria	983	779	27	56	57	74
Hungary	2,107	1,469	38	70	44	73
Poland	4,130	3,895	28	59	55	78
Former USSR states	29,610	21,749	15	37	18	70
Japan	25,088	39,498	30	53	17	27
China	1,100	6,200	27	54	47	53
Taiwan	366	3,884	39	54	67	34
South Korea	168	2,964	50	62	78	46
Singapore	124	891	39	45	48	59
Hong Kong ^c	NA	1,091	NA	57	NA	69
India	11,725	7,851	18	35	30	43
Australia	8,138	9,747	32	54	38	49
New Zealand	1,722	1,830	30	54	44	58
Argentina	892	1,581	35	58	34	53
Brazil	1,438	2,760	46	67	53	64
Chile	561	700	41	67	50	67
Mexico	648	1,408	52	66	53	67
Israel	3,698	4,322	51	66	44	56
Egypt	1,060	1,136	36	51	42	57
South Africa	1,782	1,744	44	55	29	48
Nigeria	780	342	28	55	50	64
	267	253	32	70	68	84
Kenya	207	200	32	70	00	04

NA = not available

NOTE: Details may not add to totals because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

^aData include all scientific and technical articles in natural science and engineering fields.

blnternational collaboration rates for the entire world cannot be compared to country rates because, regardless of the number of countries involved, an internationally coauthored article is counted only once.

^cData for Hong Kong are included with United Kingdom through 1986.

Appendix table 5-53. Coauthored and internationally coauthored scientific and technical articles for selected countries, by field: 1981-85 and 1991-95

and 1991-95		Num	ber of articl	es (in thousa	ands)			Percent of	total articles	
	То	tal	Multi-	author		tionally hored	Multi-	author	Interna coaut	tionally hored
Country	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95
			All natura	ıl science aı	nd enginee	ring fields				
World ^a	1,875.4	2,117.3	657.3	1,002.9	121.0	271.9	35	47	6	13
United States	697.9	773.7	311.8	431.3	60.0	126.2	45	56	9	16
United Kingdom	168.5	186.2	58.9	96.2	24.7	48.1	35	52	15	26
Germany	145.0	174.6	49.3	88.1	23.5	52.7	34	50	16	30
France	100.4	132.2	46.7	81.3	17.9	42.2	46	61	18	32
Italy	48.0	76.9	26.9	53.5	9.0	25.2	56	70	19	33
Other S. Europe	29.9	74.0	12.1	41.7	5.7	23.9	41	56	19	32
Nordic countries	78.2	96.3	41.1	62.8	16.1	34.5	52	65	21	36
Other W. Europe	99.3	136.2	42.1	82.8	22.9	51.9	42	61	23	38
Japan	138.4	200.6	46.0	100.0	8.6	25.5	33	50	6	13
Canada	84.5	103.9	36.1	59.3	15.1	29.5	43	57	18	28
Eastern Europe	57.2	58.1	20.1	32.8	10.0	23.8	35	56	17	41
Former USSR	152.9	134.6	24.3	39.0	4.5	22.9	16	29	3	17
Baltic states	NA	1.9	NA	1.1	NA	1.0	NA	57	NA	51
Russia	NA	59.3	NA	19.5	NA	12.5	NA	33	NA	21
Other former USSR	152.9	73.3	24.3	18.5	4.5	9.4	16	25	3	13
Israel	22.6	25.6	12.2	16.9	5.3	9.4	54	66	24	37
Near East/N. Africa	12.2	17.6	5.3	9.6	3.4	6.5	43	54	28	37
Other Africa	19.5	21.3	8.6	12.8	4.2	8.3	44	60	21	39
India	55.7	43.8	10.8	14.5	3.5	5.9	19	33	6	13
Central America	5.9	9.6	3.2	6.2	2.2	4.4	55	64	37	46
South America	20.2	32.7	9.0	20.4	4.8	13.1	44	62	24	40
Aust. & N. Zealand	52.6	62.6	18.1	31.8	7.3	15.6	34	51	14	25
China	9.1	30.8	3.4	16.1	7.3 2.1	8.8	34 37	51 52	23	25 29
Asian NIEs ^b	5.6	37.5	2.4	20.0	1.5	9.1	42	53	23 27	24
Other Asian/Pacific	5.0 5.9	9.2	2.4	6.4	2.3	5.2	50	70	39	57
Other Asian/Facilic	5.9	9.2	2.9	Clinical r		5.2	30	70	39	- 37
World ^a	598.7	664.8	288.4	384.1	28.7	64.1	48	58	5	10
United States	251.4	267.1	141.8	170.0	15.0	32.9	56	64	6	12
United Kingdom	62.8	71.5	26.5	38.9	6.1	12.9	42	54	10	18
Germany	42.6	48.4	16.5	26.0	4.2	10.0	39	54	10	21
_ *	30.4	36.2	15.8	23.8	3.4	8.0	52	66	11	22
FranceItaly	16.5	26.7	9.3	23.6 18.6	2.0	6.2	52 56	70	12	23
Other S. Europe									15	23 21
•	6.2	17.7	2.9	10.8	0.9	3.8	47 61	61 70		
Nordic countries	40.7	42.3	24.8	30.3	6.3	11.7	61	72 67	15 17	28
Other W. Europe	37.6	50.4	18.4	33.9	6.5	15.7	49	67	17	31
Japan	34.8	59.2	14.7	33.2	2.1	6.5	42	56	6	11
Canada	23.5	30.2	13.5	20.7	3.5	7.7	58	68	15	26
Eastern Europe	9.9	7.6	4.2	4.7	1.4	2.9	42	63	15	39
Former USSR	19.3	11.4	4.9	3.7	0.4	1.3	25	33	2	12
Baltic states	NA	0.2	NA	0.1	NA	0.1	NA	69	NA	60
Russia	NA	4.4	NA	1.6	NA	0.6	NA	36	NA	14
Other former USSR	19.3	6.7	4.9	2.0	0.4	0.6	25	30	2	9
Israel	7.8	8.4	5.5	6.4	1.1	1.9	70	77	14	23
Near East/N. Africa	2.8	4.3	1.4	2.6	0.7	1.4	50	61	26	32
Other Africa	8.3	8.1	4.7	5.8	1.6	3.4	57	71	19	41
India	7.1	5.8	2.1	2.6	0.3	0.7	29	45	5	11
Central America	2.1	2.1	1.2	1.5	0.6	0.9	59	69	29	44
South America	5.6	8.4	2.8	5.4	1.1	2.8	50	65	19	34
Aust. & N. Zealand	16.6	20.6	6.8	11.4	1.6	3.9	41	55	10	19
China	1.4	3.1	0.7	1.9	0.3	1.4	48	61	21	43
Asian NIEsb	1.1	8.0	0.6	5.2	0.4	1.8	58	65	32	22
Other Asian/Pacific	1.7	2.7	1.0	2.1	0.7	1.6	59	77	40	59

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Appendix table 5-53. Coauthored and internationally coauthored scientific and technical articles for selected countries, by field: 1981-85 and 1991-95

		Num	nber of articl	es (in thousa	ands)			Percent of	total articles	;
	To	otal	Multi-	author		tionally hored	Multi-	author		tionally hored
Country	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95
				Biomedica	al research					
World ^a	290.8	351.8	107.4	179.4	20.7	48.4	37	51	7	14
United States	119.0	149.8	54.6	88.7	10.8	25.6	46	59	9	17
United Kingdom	27.1	32.5	9.2	17.2	4.5	9.5	34	53	17	29
Germany	22.3	27.0	8.0	14.7	4.3	9.5	36	54	19	35
France	16.1	22.9	8.0	14.2	3.0	7.3	49	62	19	32
Italy	7.0	11.2	4.0	8.1	1.4	3.7	58	72	21	33
Other S. Europe	4.8	10.3	1.8	5.6	0.7	3.3	38	55	14	32
Nordic countries	12.5	16.4	6.4	11.0	3.1	6.7	51	67	25	41
Other W. Europe	15.8	23.9	7.0	15.0	4.0	9.9	44	62	25	41
Japan	19.8	31.7	7.5	18.3	1.6	5.0	38	58	8	16
Canada	13.4	17.8	5.9	10.8	2.4	5.3	44	61	18	30
Eastern Europe	8.8	8.0	3.4	4.6	1.6	3.2	39	58	19	40
Former USSR	19.6	19.3	4.2	6.4	8.0	3.0	21	33	4	15
Baltic states	NA	0.2	NA	0.2	NA	0.1	NA	68	NA	59
Russia	NA	8.3	NA	3.0	NA	1.6	NA	36	NA	19
Other former USSR	19.6	10.8	4.2	3.3	0.8	1.3	21	30	4	12
Israel	3.6	4.1	1.9	2.7	0.9	1.7	53	66	25	42
Near East/N. Africa	1.0	1.2	0.5	0.7	0.3	0.5	51	62	32	47
Other Africa	2.0	2.8	0.8	1.7	0.5	1.1	42	61	25	41
India	7.3	5.5	1.2	1.8	0.4	0.7	16	32	5	13
Central America	0.8	1.5	0.4	1.0	0.3	0.7	52	66	33	47
South America	3.7	5.4	1.7	3.4	0.8	2.0	45	62	20	37
Aust. & N. Zealand	6.9	9.4	2.4	4.9	1.1	2.7	34	52	16	29
China	0.6	2.4	0.3	1.2	0.2	0.8	47	52	32	35
Asian NIEsb	0.4	3.4	0.2	2.1	0.1	1.0	47	62	30	30
Other Asian/Pacific	0.7	1.1	0.4	0.9	0.3	0.7	57	76	44	63
				Bio	logy					
$\textbf{World}^a \dots \dots$	189.1	171.7	51.6	69.1	10.5	19.6	27	40	6	11
United States	73.7	62.9	25.7	29.0	5.0	8.3	35	46	7	13
United Kingdom	18.0	14.4	4.2	6.3	2.0	3.5	23	44	11	25
Germany	11.4	9.8	3.0	4.0	1.6	2.5	26	41	14	26
France	6.9	7.6	2.8	4.2	1.1	2.1	40	55	16	28
Italy	2.4	3.3	1.0	1.9	0.4	0.9	43	58	16	28
Other S. Europe	2.2	6.7	0.8	3.1	0.5	1.7	35	46	21	25
Nordic countries	5.6	7.9	1.8	3.6	1.0	2.1	33	46	17	27
Other W. Europe	7.6	8.9	2.2	4.4	1.2	2.8	29	49	16	31
Japan	12.6	13.7	3.7	6.4	0.7	1.6	29	47	6	12
Canada	14.3	14.5	4.4	6.7	1.6	2.8	31	46	11	19
Eastern Europe	5.0	2.9	1.5	1.5	0.7	1.1	30	52	13	37
Former USSR	5.4	4.4	0.9	1.1	0.2	0.5	17	24	3	12
Baltic states	NA	0.1	NA	0.0	NA	0.0	NA	53	NA	47
Russia	NA	2.3	NA	0.5	NA	0.3	NA	23	NA	13
Other former USSR	5.4	2.1	0.9	0.5	0.2	0.2	17	24	3	10
Israel	2.3	2.3	1.0	1.4	0.4	0.8	41	59	19	33
Near East/N. Africa	1.6	1.8	0.7	1.0	0.5	0.8	43	58	29	46
Other Africa	4.4	4.8	1.4	2.5	0.9	1.8	31	52	21	37
India	8.1	3.6	1.1	1.1	0.4	0.5	14	30	5	15
Central America	1.0	1.9	0.5	1.1	0.4	0.8	49	58	42	45
South America	2.8	3.9	1.3	2.3	0.8	1.6	46	59	30	40
Aust. & N. Zealand	11.6	12.4	3.5	5.6	1.2	2.4	30	45	11	19
China	1.2	1.3	0.3	0.9	0.2	0.7	28	65	16	53
Asian NIEs ^b	0.6	2.0	0.2	1.0	0.2	0.6	42	53	32	29
Other Asian/Pacific	1.6	2.3	0.7	1.5	0.6	1.3	45	68	38	59

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Appendix table 5-53.

Coauthored and internationally coauthored scientific and technical articles for selected countries, by field: 1981-85 and 1991-95

and 1991-95		Num	nber of articl	es (in thousa	ands)			Percent of	total articles	
	То	tal	Multi-	author		tionally hored	Multi-	author		tionally hored
Country	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95
				Chen	nistry					
World ^a	273.4	296.1	62.4	101.1	15.0	31.5	23	34	5	11
United States	59.1	69.9	16.7	27.1	5.4	10.1	28	39	9	14
United Kingdom	19.0	19.9	5.8	9.3	3.2	5.0	31	47	17	25
Germany	24.7	29.6	6.7	11.8	3.4	6.7	27	40	14	23
France	16.6	20.4	6.4	10.7	2.6	5.7	39	52	16	28
Italy	8.6	10.5	4.2	6.6	1.3	2.7	49	63	15	26
Other S. Europe	7.8	15.5	2.7	7.8	1.1	4.5	35	50	14	29
Nordic countries	5.7	7.8	2.1	4.1	1.2	2.8	36	53	21	36
Other W. Europe	12.1	15.4	3.6	7.2	2.3	4.9	30	47	19	32
Japan	29.6	33.6	7.1	12.4	1.1	2.6	24	37	4	8
Canada	9.1	10.0	2.7	4.0	1.7	2.5	30	39	18	25
Eastern Europe	17.2	16.8	5.5	8.2	2.5	5.0	32	49	14	30
Former USSR	46.7	35.2	7.0	7.8	1.0	3.6	15	22	2	10
Baltic states	NA	0.4	NA	0.2	NA	0.2	NA	43	NA	38
Russia	NA	15.6	NA	3.8	NA	1.8	NA	24	NA	12
Other former USSR	46.7	19.2	7.0	3.9	1.0	1.6	15	20	2	8
Israel	2.0	1.9	0.7	1.1	0.5	0.7	37	56	23	39
Near East/N. Africa	3.2	4.7	1.1	2.2	0.6	1.5	34	47	20	31
Other Africa	1.7	1.8	0.6	0.8	0.4	0.6	34	45	23	32
India	15.3	12.4	2.0	2.8	0.7	1.0	13	22	4	8
Central America	0.6	1.0	0.3	0.7	0.2	0.4	54	64	44	41
South America	2.5	3.9	0.7	2.1	0.4	1.3	30	54	17	34
Aust. & N. Zealand	5.4	5.5	1.6	2.6	0.8	1.4	30	47	15	25
China	0.8	6.1	0.3	2.4	0.2	1.1	33	39	22	18
Asian NIEs ^b	1.1	7.4	0.3	3.2	0.2	1.2	27	44	15	17
Other Asian/Pacific	0.6	1.2	0.2	0.7	0.2	0.5	41	61	35	45
	0.40.0	200.4			sics	20.7				
World ^a	240.2	339.4	68.1	148.8	23.3	63.7	28	44	10	19
United States	73.2	102.7	29.2	56.1	10.6	25.7	40	55	14	25
United Kingdom	16.6	22.8	5.6	12.5	4.0	9.1	34	55	24	40
Germany	22.6	37.7	8.8	21.1	6.2	16.3	39	56	27	43
France	17.3	26.8	8.4	17.6	4.9	12.2	49	66 70	28	45 50
Italy	8.0	15.5	5.6	12.0	2.5	7.8	70	78	32	50
Other S. Europe	4.6	13.1	2.3	8.7	1.4	6.7	49	66	31	51
Nordic countries	6.7	11.9	3.4	8.2	2.8	7.0	51	69	42	59
Other W. Europe	14.9	23.3	6.8	14.6	5.8	12.6	46	63	39	54
Japan	20.8	40.1	6.2	19.2	1.5	6.0	30	48	7	15
Canada	8.4	12.1	3.4	7.0	2.2	5.0	40	58 64	26 25	41 55
Eastern Europe	9.2	15.4	3.5	9.8	2.3	8.4	38 10	64 21	25	55 22
Former USSR	40.2	47.8	3.9	14.8	1.5	11.1	10	31	4	23
Baltic states	NA	0.7	NA	0.4	NA	0.4	NA	56	NA	51
Russia	NA 40.2	21.4	NA 2.0	8.0	NA 1.5	6.3	NA 10	37 25	NA 4	30 17
Other former USSR	40.2	25.6	3.9	6.4	1.5	4.4	10 40	25 63	4	17 51
Israel	3.3	5.1	1.6	3.2	1.3	2.6	49 46	63 57	38	51
Near East/N. Africa	1.1	2.3	0.5	1.3	0.4	1.0	46 40	57 56	35 21	44
Other Africa	0.8	1.3	0.3	0.7	0.2	0.5	40	56 40	31	42
India	8.9	9.1	2.1	3.7	0.8	1.8	24	40	9	20 45
Central America	0.8	1.8	0.5	1.1	0.3	0.8	55	63	39	45 47
South America	3.0	6.8	1.2	4.4	0.8	3.2	41	64	25	47
Aust. & N. Zealand	3.8	5.5	1.1	2.6	0.7	1.9	28	47 60	18	35
China	2.1	11.2	0.7	6.7	0.4	2.7	33	60	19	24
Asian NIEsb	0.9	7.6	0.4	4.3	0.2	2.1	40	57	25	28
Other Asian/Pacific	0.5	0.8	0.2	0.5	0.1	0.4	38	62	31	52

Appendix table 5-53. Coauthored and internationally coauthored scientific and technical articles for selected countries, by field: 1981-85 and 1991-95

		Num	nber of articl	es (in thousa	ands)			Percent of	total articles	
	То	ıtal	Multi-	author		tionally hored	Multi-	author		tionally hored
Country	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95
			E	arth and sp	ace science	es				
World ^a	84.3	107.2	29.5	53.4	9.5	21.8	35	50	11	20
United States	38.3	49.1	17.0	28.6	5.5	11.9	45	58	14	24
United Kingdom	8.5	11.0	3.5	6.5	2.4	4.8	41	60	28	43
Germany	5.1	7.7	2.4	4.9	1.8	4.0	46	63	35	52
France	4.4	7.2	2.5	5.2	1.5	3.7	56	73	33	51
Italy	2.0	4.1	1.3	3.2	0.8	2.0	64	78	37	50
Other S. Europe	1.2	4.2	0.6	2.6	0.5	1.8	53	63	40	44
Nordic countries	2.5	5.1	1.2	3.3	0.9	2.5	48	64	35	48
Other W. Europe	3.6	6.2	1.8	3.9	1.4	3.2	49	64	40	52
Japan	2.4	5.0	1.1	3.1	0.4	1.6	46	62	18	32
Canada	5.6	8.8	2.5	5.2	1.4	3.2	45	59	26	36
Eastern Europe	1.4	2.0	0.5	1.2	0.4	1.0	38	61	25	51
Former USSR	8.3	7.1	1.5	2.7	0.4	1.9	19	38	5	27
Baltic states	NA	0.1	NA	0.1	NA	0.1	NA	68	NA	63
Russia	NA	3.4	NA	1.4	NA	1.1	NA	42	NA	32
Other former USSR	8.3	3.5	1.5	1.2	0.4	0.7	19	34	5	21
Israel	0.8	1.2	0.4	0.7	0.3	0.5	53	63	37	46
Near East/N. Africa	0.5	0.9	0.2	0.5	0.2	0.4	51	56	42	42
Other Africa	1.0	1.7	0.4	0.9	0.3	0.7	38	55	30	39
India	2.6	2.5	0.6	0.9	0.3	0.5	23	37	11	21
Central America	0.3	0.7	0.2	0.5	0.2	0.4	59	71	53	61
South America	1.1	2.2	0.6	1.6	0.5	1.4	54	73	47	60
Aust. & N. Zealand	3.9	4.9	1.5	2.9	1.0	2.0	38	58	25	40
China	1.4	1.4	0.4	0.9	0.2	0.7	31	66	18	52
Asian NIEsb	0.1	1.0	0.1	0.6	0.1	0.4	52	61	45 55	44
Other Asian/Pacific	0.2	0.5	0.1	0.3 gineering a	0.1	0.3	60	71	55	64
World ^a	149.7	146.4	38.2	52.7	8.0	15.4	25	36	5	11
United States	62.2	54.9	19.2	23.5	4.4	7.5	31	43	7	14
United States United Kingdom	12.9	11.2	3.0	4.2	1.6	2.3	23	37	12	20
Germany	11.8	11.1	2.9	4.3	1.3	2.5	25	39	11	22
France	5.2	7.2	1.8	3.7	0.8	1.9	35	51	15	27
Italy	2.5	4.0	1.0	2.2	0.3	1.1	40	54	14	27
Other S. Europe	2.1	4.9	0.7	2.3	0.4	1.4	33	47	21	29
Nordic countries	3.2	3.8	0.9	1.7	0.5	1.2	28	46	17	31
Other W. Europe	5.4	5.9	1.6	2.7	1.1	1.9	30	46	20	33
Japan	15.8	15.6	5.2	6.8	0.8	1.9	33	44	5	12
Canada	7.2	8.0	2.4	3.6	1.3	2.0	34	45	18	25
Eastern Europe	3.6	3.6	1.0	1.7	0.6	1.3	28	48	17	37
Former USSR	10.6	7.9	1.7	2.1	0.2	1.0	16	26	2	13
Baltic states	NA	0.1	NA	0.0	NA	0.0	NA	50	NA	45
Russia	NA	3.3	NA	1.0	NA	0.6	NA	29	NA	17
Other former USSR	10.6	4.4	1.7	1.1	0.2	0.4	16	24	2	10
Israel	1.8	1.6	0.7	0.8	0.4	0.6	37	50	25	36
Near East/N. Africa	1.6	2.2	0.7	1.0	0.5	8.0	43	46	34	35
Other Africa	1.0	0.7	0.3	0.3	0.2	0.2	29	40	16	28
India	4.8	4.5	1.3	1.5	0.4	0.5	27	34	9	12
Central America	0.2	0.3	0.1	0.2	0.1	0.1	52	57	45	43
South America	0.9	1.3	0.4	0.8	0.3	0.5	47	58	29	38
Aust. & N. Zealand	3.1	3.1	8.0	1.3	0.5	0.9	26	42	15	27
China	1.0	4.0	0.4	1.7	0.4	1.0	41	42	34	26
Asian NIEsb	1.1	7.3	0.4	3.2	0.3	1.6	39	43	28	22
Other Asian/Pacific	0.4	0.4	0.2	0.3	0.1	0.2	44	62	40	51

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Appendix table 5-53. Coauthored and internationally coauthored scientific and technical articles for selected countries, by field: 1981-85 and 1991-95

		Nun	nber of articl	es (in thousa	ands)			Percent of	total articles	
	То	tal	Multi-	author		ationally thored	Multi-	author		tionally hored
Country	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95	1981-85	1991-95
				Mathe	matics					
World ^a	48.1	39.8	11.5	14.4	5.2	7.4	24	36	11	19
United States	20.0	17.3	7.2	8.1	3.2	4.1	36	47	16	24
United Kingdom	3.6	2.9	1.1	1.3	0.9	1.0	31	45	25	36
Germany	4.5	3.3	1.0	1.4	0.8	1.2	22	42	18	36
France	3.4	4.0	1.0	1.8	0.7	1.2	30	46	21	29
Italy	1.0	1.6	0.4	0.9	0.3	0.6	41	56	27	39
Other S. Europe	1.0	1.7	0.2	0.8	0.2	0.7	25	49	19	39
Nordic countries	1.3	1.2	0.4	0.6	0.4	0.5	33	49	28	41
Other W. Europe	2.3	2.2	0.7	1.1	0.6	0.9	31	49	26	42
Japan	2.6	1.7	0.5	0.6	0.3	0.3	20	35	12	19
Canada	2.9	2.5	1.2	1.4	1.0	1.2	43	56	37	47
Eastern Europe	2.0	1.7	0.6	0.9	0.5	0.8	29	52	23	47
Former USSR	2.9	1.6	0.3	0.4	0.1	0.4	9	27	3	22
Baltic states	NA	0.0	NA	0.0	NA	0.0	NA	75	NA	63
Russia	NA	0.6	NA	0.2	NA	0.2	NA	37	NA	33
Other former USSR	2.9	1.0	0.3	0.2	0.1	0.1	9	19	3	15
Israel	1.0	1.0	0.5	0.6	0.4	0.5	47	60	41	55
Near East/N. Africa	0.4	0.3	0.2	0.2	0.2	0.2	35	48	34	45
Other Africa	0.3	0.2	0.1	0.1	0.1	0.1	29	48	25	37
India	1.7	0.5	0.4	0.2	0.2	0.2	26	42	14	31
Central America	0.1	0.2	0.1	0.1	0.0	0.1	44	57	38	43
South America	0.5	8.0	0.2	0.4	0.2	0.3	46	58	38	46
Aust. & N. Zealand	1.2	1.1	0.4	0.6	0.4	0.5	36	55	30	49
China	0.5	1.3	0.3	0.5	0.2	0.4	48	43	43	34
Asian NIEs ^b	0.3	8.0	0.1	0.4	0.1	0.3	43	47	35	38
Other Asian/Pacific	0.1	0.2	0.1	0.1	0.1	0.1	39	58	39	55

NA = not available; NIEs = newly industrialized economies

NOTE: Details may not add to totals because of rounding.

SOURCE: Institute for Scientific Information, Science Citation Index; CHI Research Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

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^aInternational collaboration rates for the entire world cannot be compared to country rates because, regardless of the number of countries involved, an internationally coauthored article is counted only once.

^bData for Hong Kong are included with United Kingdom through 1986.

Appendix table 5-54. Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

							Collabora	Collaborating country (by country code)	untry (by	country	(epoo						
								-	1981-85								
Code Country/region	-	8	က	4	2	9	7	œ	6	10	Ξ	13	4	15	16	17	19
Articles (thousands)	697.9	84.5	168.5	100.4	145.0	11.8	۱ , .	3.8	0.1	35.4	29.1		4.9	1.4	16.7	1.6	18.1
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1 United States		12	13	7	Ξ	-		0	0	က	4		-	0	_	0	7
2 Canada	47		9	æ	4	0		0	0	7	2		0	0	0	0	-
3 United Kingdom	28	9		7	80	-		-	0	4	က		-	-	-	0	2
4 France	23	9	6		10	_		0	0	က	9		-	_	2	0	-
5 Germany	25	2	6	œ		က		0	0	4	7		-	0	-	0	2
6 Austria	16	7	80	2	28			0	0	ო	80		0	0	-	0	-
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10 Netherlands	24	က	13	ω	12	-		0	0		4		0	0	-	0	7
	22	7	တ	Ξ	18	7		0	0	က			-	0	-	0	7
	22	7	13	13	တ	-		0	0	4	ω		0	0	7	0	-
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	22	7	22	17	7	0		-	0	7	7		0		7	0	-
	20	7	13	20	∞	-		0	0	က	4		0	0		0	-
	36	က	9	4	17	-		0	0	-	-		-	0	-		-
	22	4	12	2	တ	-		0	0	က	4		0	0	-	0	
	23	4	တ	2	∞	-		0	0	က	က		0	0	0	0	4
	22	က	12	4	ဝ	-		0	0	7	2		0	-	0	0	ဝ
	56	7	တ	2	တ	-		0	0	က	4		0	0	-	0	о
	56	9	7	က	9	0		0	0	-	-		0	0	0	0	=
	4	-	က	9	22	က		0	0	-	0		-	0	0	0	-
	18	က	9	2	19	က		0	0	က	7		0	0	0	0	-
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Appendix table 5-54. Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

						J	Sollabora	ting cor	Collaborating country (by country code)	country	(epoo .						
								~	1981-85								
Code Country/region	-	N	က	4	2	9	7	æ	6	9	=	5	4	15	16	11	19
41 Hong Kong	¥	NA	NA	A A	¥	Ą	A A	¥	NA	¥	A A	Ą	ΑĀ	¥	Ą	AA	Ā
42 India	34	6	12	4	우	0	-	0	0	7	7	က	0	0	0	0	-
44 Australia	33	7	21	4	2	-	-	0	0	7	7	-	0	0	0	0	7
45 New Zealand	59	∞	18	7	2	-	-	0	0	-	-	-	0	0	0	0	-
46 Israel	22	က	7	2	Ξ	0	-	0	0	7	က	7	0	0	0	0	-
48 Argentina	32	က	ω	တ	10	0	-	0	0	7	-	4	0	0	7	0	-
49 Brazil	37	9	6	10	∞	0	-	0	0	-	2	4	0	0	-	0	-
50 Chile	37	2	7	7	∞	0	-	0	0	2	-	2	0	0	7	0	-
52 Mexico	51	9	2	œ	2	0	_	0	0	0	2	7	0	0	4	0	0
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of South Africa	30	ဂ	70	n	0	5	_	>	5	N	N	_	0	>	>	>	_
								"	1981-85								
Code Country/region	20	2	52	23	54	22	56	27	28	53	સ	32	33	34	36	37	88
Articles (thousands)	13.4	11.2	35.3			11.4	_ ا	16.5	Ą	₹	152.9	¥	Ą	¥	138.4	9.1	2.8
Multi-author (%)	20	49	54			44		36	Ϋ́	Ϋ́	16	ΑN	Ą	Ϋ́	33	37	43
International (%)	17	21	20	44	19	21	18	15	Ą	A	ო	Α	Ϋ́	ΑN	9	23	56
1 United States	-	-	က			-		0	0	0	_	0	0	0	7	2	-
2 Canada	-	-	-			-		0	0	0	0	0	0	0	က	-	0
3 United Kingdom	-	-	က			-		0	0	0	0	0	0	0	7	-	0
	-	-	2			-		-	0	0	-	0	0	0	7	-	0
5 Germany	-	-	က			7		2	0	0	2	0	0	0	က	-	0
-	-	_	2			2		-	0	0	7	0	0	0	7	0	0
	-	.	က			.		-	0	0	-	0	0	0	0	0	0
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Appendix table 5-54. Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

							-	Collabor	Collaborating country (by country code)	untry (by	country	(apoo						
									<u>~</u>	1981-85								
Code	Country/region	20	21	22	23	24	25	26	27	28	29	31	32	33	34	36	37	38
25	Hungary	-	0	2	0	-		3	2	0	0	12	0	0	0	2	0	0
56	Poland	-	-	4	0	-	7		4	0	0	2	0	0	0	-	0	0
27	Czechoslovakia	7	-	7	0	က	2	9		0	0	22	0	0	0	-	0	0
58	Czech Republic	Α	Ϋ́	Α	Α	¥	A	ΑN	¥	Α	Ϋ́	¥	ΑĀ	Α	¥	Α	¥	Ν
53	Slovakia	Ν	¥	Ϋ́	Α̈́	¥	Ν	ΑN	¥	¥	Ϋ́	¥	ΑĀ	ΑĀ	¥	Ϋ́	¥	Ν
3	USSR	7	-	7	0	7	9	2	13	0	0		0	0	0	-	0	0
35	Russia	Ν	¥	Ϋ́	Ϋ́	¥	NA	ΑA	¥	ΑĀ	Ϋ́	¥	¥	ΑĀ	¥	Ϋ́	¥	ΑA
ဗ္ဗ	Ukraine	Ν	¥	Ϋ́	Α̈́	¥	Ν	ΑN	¥	¥	Ϋ́	¥	ΑĀ	ΑĀ	¥	Ϋ́	¥	Ν
34	Baltic states	Ν	Š	Ϋ́	Ϋ́	Ϋ́	ΑĀ	ΑN	ΑĀ	ΑĀ	ΑĀ	ΑĀ	Ϋ́	Ϋ́	ΑĀ	Ϋ́	Ϋ́	Ν
36	Japan	0	0	7	0	0	-	-	0	0	0	-	0	0	0		7	7
37	China	0	0	7	0	0	0	0	0	0	0	0	0	0	0	ω		0
88	Taiwan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	-	
33	South Korea	0	0	-	0	0	0	0	0	0	0	0	0	0	0	18	0	0
40	Singapore	0	0	7	0	0	-	0	0	0	0	0	0	0	0	က	0	0
4	Hong Kong	Ν	¥	Ϋ́	Ϋ́	¥	Ν	ΑN	¥	ΑĀ	Ϋ́	¥	Ϋ́	ΑĀ	¥	Ϋ́	¥	ΑN
42	India	0	0	2	0	0	0	0	-	0	0	-	0	0	0	2	0	0
4	Australia	-	0	7	0	0	0	0	0	0	0	0	0	0	0	2	_	0
45	New Zealand	0	-	-	0	0	0	-	0	0	0	0	0	0	0	7	0	0
46	Israel	0	0	7	0	0	0	0	0	0	0	0	0	0	0	-	0	0
48	Argentina	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	Brazil	0	0	-	0	0	0	-	0	0	0	0	0	0	0	7	0	0
20	Chile	0	-	-	0	0	0	0	0	0	0	0	0	0	0	_	0	0
25	Mexico	0	0	-	0	0	0	-	0	0	0	-	0	0	0	-	0	0
24	Egypt	0	-	-	0	0	-	-	-	0	0	-	0	0	0	7	0	0
26	South Africa	0	0	-	0	0	0	0	0	0	0	0	0	0	0	-	0	0
								1981-85	,,									
Code	Country/region	33	40	4	45	4	45	46	48	49	20	25	54	26				
	Articles (thousands) Multi-author (%)	7.1 4	1.1	4 4 4 4 4 4	55.7 19 6	43.2 35	9.4 32 15	22.6 54 24	5.6 35	8.3 47 25	3.3 7.0 7.0 7.0 7.0	4.0 55	5.6	9.9 47				
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ა 4	United Kingdom	o c	o c	0 0	ν -	ი –	- c	ν -						- c				
. 13	Germany	0	0	0	-		0	۰ ۵						· -				
9	Austria	0	0	0	-	2	0	ι —						0				
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Appendix table 5-54.

Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

						Collabo	rating c	Collaborating country (by country code)	y count	ry code)	_			
								1981-85						
Code	Code Country/region	33	40	4	45	4	45	46	48	49	20	25	54	26
7	Belgium	0	0	0	-	-	0	-	0	0	0	0	0	0
œ	Ireland	0	0	0	-	7	0	-	0	0	0	0	0	0
6	Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Netherlands	0	0	0	-	-	0	7	0	0	0	0	0	0
Ξ	Switzerland	0	0	0	-	-	0	2	0	0	0	0	0	0
13	Italy	0	0	0	-	-	0	-	0	-	0	0	0	0
4	Greece	0	0	0	0	_	0	-	0	0	0	0	0	0
15	Portugal	0	0	0	0	-	0	-	0	-	0	0	0	0
16		0	0	0	0	-	0	0	-	-	7	7	0	0
17		0	0	0	-	0	0	-	0	0	0	0	0	0
19	Denmark	0	0	0	-	7	0	-	0	0	0	0	0	0
20	Finland	0	0	0	0	7	0	-	0	0	0	0	0	0
2	Norway	0	0	0	-	_	0	-	0	0	0	0	0	0
52	Sweden	0	0	0	-	-	0	-	0	0	0	0	0	0
83	Iceland	0	0	0	0	-	0	0	0	0	0	0	0	0
24	Bulgaria	0	0	0	-	0	0	0	0	0	0	0	0	0
22		0	0	0	0	-	0	0	0	0	0	0	0	0
56		0	0	0	0	_	0	0	0	0	0	0	0	0
27	_	0	0	0	-	0	0	0	0	0	0	0	0	0
78	Czech Republic	ΑĀ	ΑĀ	¥	Ϋ́	Ϋ́	Ν	Ν	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ϋ́
59	Slovakia	ΑĀ	Ν	Ϋ́	Ν	Ž	¥	Α	ΑN	ΑĀ	Ν	Ν	Ν	Α
સ		0	0	0	-	0	0	0	0	0	0	0	0	0
35	Russia	ΑĀ	Ν	Υ	Ϋ́	Ž	¥	Α	ΑN	Α	Ϋ́	Ν	Ν	¥
ဗ္ဗ	_	ΑĀ	ΑN	Υ	Ϋ́	¥	¥	Α	ΑĀ	Α	Ϋ́	ΑN	ΑN	¥
8	_	Ϋ́	ΑN	Ϋ́	Ϋ́	¥	¥	Ϋ́	Α	Ϋ́	Ϋ́	Υ	ΑN	Ϋ́
36	-	_	0	0	7	5	0	-	0	-	0	0	0	0
37	_	0	0	0	0	က	0	0	0	0	0	0	0	0
38	Taiwan	0	0	0	-	0	0	-	0	0	0	0	0	-
39			0	0	0	0	0	0	0	0	0	0	0	0
40	Singapore	0		0	9	12	_	0	0	-	-	-	_	-
4		Ϋ́	ΑN	Ϋ́	Ϋ́	¥	¥	Ϋ́	Α	Ϋ́	Ϋ́	Υ	ΑN	Ϋ́
45	India	0	0	0		က	0	-	0	-	0	0	0	0
4	_	0	-	0	-		2	-	0	0	0	0	0	-
45	New Zealand	0	0	0	-	21		0	0	0	0	0	0	-
46	Israel	0	0	0	0	_	0		0	0	0	0	0	-
48		0	0	0	0	-	0	-		10	က	7	0	0
49	Brazil	0	0	0	-	-	0	-	က		1	-	0	0

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Appendix table 5-54. Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

						Collabor	ating co	Sollaborating country (by country code)	y country	/ code)				Ī	Ī			
								1981-85										
Code	Code Country/region	39	40	4	42	4	45	46	48	49	20	25	54	26				
50	Chile	0 0	0 0	0 0		е	00	- 0	ю _τ	4 0	,	-	0 0	0 0				
5 2	Mexico Egypt	0	0 0	0		0	0	0 0	- 0	v 0	- 0	0	5	0				
26	South Africa	0	0	0	0	2	-	9	0	0	0	0	0					
									-	1991-95								
Code	Code Country/region	-	8	ო	4	Ŋ	9	7	80	6	9	£	13	4	15	16	11	19
	Articles (thousands)	773.7	103.9	186.2	132.2	174.6	16.1	24.1	5.0	0.1	52.7	38.1		9.3	4.5	46.1	5.8	21.9
	Multi-author (%)	26	22	52	61	20	61	9	29	71	61	29	20		29	54	53	65
	International (%)	16	28	56	32	30	37	42	38	29	31	45			48	29	25	39
-	United States		10	10	80	10	_	7	0	0	က	က	2	_	0	2	0	2
8	Canada	41		œ	œ	2	_	-	0	0	7	7	က	0	0	-	0	_
က	United Kingdom	23	4		7	∞	-	7	-	0	4	က	9	-	-	4	0	7
4	France	20	2	ω		9	-	4	0	0	က	2	9	-	-	2	0	-
2	Germany	22	က	7	ω		က	0	0	0	4	9	2	-	0	7	0	2
9	Austria	16	0	9	9	24		-	0	0	က	9	4	_	0	7	0	2
7	Belgium	15	α.	၈ ု	16	တ (-	,	_	0	თ ·	4	. 2	-	-	က	0	-
∞	Ireland	16	4	27	9	∞	-	က		0	4	က	4	.	-	က	0	7
o (Luxembourg	ဖ ့	- (/ ;	17	우 9	. ,	15	0 0	(4	ა ა	တ ၊	4 ,	. ,	ကျ	0 (4 (
2 ;	Netherlands	<u></u> 6	ကျ	Ξ'	ω,	2 5	- (9 0	o (5 0	•	4	က (_ ,	- ,	n (5 (N T
= \$	Switzerland	<u> </u>	nc	φ	_ ;	9 0	N T	N C	> 0	> 0	4 (Ċ	χ		- •	N 5	> 0	– c
2 5	Italy	77	უ ი	5 5	2 =	ה -	- c	N G	o c	o c	ກເ	οч	Ľ	_	- c	4 ი	o c	νc
15	Portugal	2	0 0	1 4	- 2	<u>-</u> ∞	٦ -) 4	0	0 0	1 4) 4	ာဖ	co	J	ာ ဖ	0	٦ -
16	Spain	18	8	12	15	တ	-	8	0	0	က	က	œ	-	-		0	8
17	Turkey	25	7	4	4	13	-	7	0	0	က	4	2	-	0	7		-
19	Denmark	18	က	Ξ	9	10	-	7	0	0	4	က	4	_	0	7	0	
20	Finland	19	က	7	2	∞	-	7	0	0	က	က	က	-	-	2	0	4
2	Norway	18	က	ω	9	7	-	7	0	0	က	က	က	0	-	7	0	7
55	Sweden	20	က	ω	2	∞	-	7	0	0	က	က	4	-	-	2	0	7
23	Iceland	22	7	10	4	2	-	7	0	0	2	-	-	-	-	0	0	13
24	Bulgaria	10	7	4	7	19	7	-	0	0	2	က	7	7	0	4	0	_
52	Hungary	22	က	7	7	16	က	0	0	0	က	4	2	0	0	-	0	-
56	Poland	17	က	9	0	16	-	7	0	0	က	က	9	-	-	7	0	7
27	Czechoslovakia	Ξ	က	9	7	18	က	7	0	0	က	က	4	-	0	7	0	7
58	Czech Republic	Ξ,	0		o (15	თ .	თ .	0	0	က	က	φ.	2	-	α.	0	- -
82	Siovakia	ი	N	၃	∞	72	4	4	0	5	N	ກ	4	7	-	-	э	_

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Appendix table 5-54. Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

							Õ	ollabora	ting cou	Collaborating country (by country code)	country	code)						
									19	1991-95								
Code Country/region	1		2	3	4	2	9	7	8	6	10	11	13	14	15	16	17	19
31 USSR		7	2	2	7	19	_	-	0	0	2	က	9	-	0	2	0	-
32 Russia		16	က	2	œ	15	-	7	0	0	7	က	2	-	0	-	0	-
33 Ukraine		80	2	က	2	10	_	-	0	0	က	-	4	-	0	7	-	-
34 Baltic states		6	က	4	4	13	0	-	0	0	7	-	4	0	0	-	0	_
36 Japan	40	0	2	7	4	7	_	-	0	0	7	7	က	0	0	-	0	-
37 China	28	8	9	7	2	о	_	-	0	0	7	7	2	-	0	-	0	-
	62	S	က	က	2	က	0	0	0	0	0	_	_	0	0	0	0	0
39 South Korea	50	0	က	က	က	4	0	0	0	0	_	-	2	0	0	-	0	0
40 Singapore	5	_α	2	17	7	က	0	-	0	0	_	7	_	0	0	0	0	-
41 Hong Kong		က	9	16	-	က	-	0	0	0	0	-	-	0	0	0	0	0
42 India		œ	9	10	2	10	-	-	0	0	7	7	2	0	0	-	0	-
44 Australia		6	9	16	4	7	_	_	0	0	2	2	2	0	0	-	0	_
45 New Zealand	28	œ	7	4	က	9	_	_	0	0	2	-	_	0	0	0	0	_
46 Israel	45	2	4	9	7	Ξ	-	-	0	0	7	က	4	0	0	-	0	-
48 Argentina		2	က	4	10	တ	_	_	0	0	_	_	2	0	0	Ξ	0	_
49 Brazil	27	7	4	6	10	7	0	2	0	0	_	က	9	-	2	က	0	_
50 Chile	31	_	4	2	7	œ	0	2	0	0	2		4	0	0	œ	0	0
		2	4	2	œ	2	0	_	0	0	_	2	က	0	0	7	0	0
		œ	4	œ	4	10	2	_	0	0	2	_	4	0	0	-	_	_
	24	4	. 7	15	က	: -	· 	2	0	0	2 1	2	က	· 	0	2	0	-
									=	1991-95								
Code Country/region	Ñ	20 2	21	22	23	24	25	26	27	28	29	31	32	33	34	36	37	38
Articles (thousands)		6	13.1	_			10.1				2.3	58.4		8.8	6	200.6	30.8	17.0
Multi-author (%) International (%)			64 36	99 99	0 / 5 54	33 20	67 49	54 72	33	61 46	56 14	ည တ	% <u>r</u>	35.	5.7	50 13	25 25	51 18
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	:		- +	י כ	o c	o c	- +	۷ +	o c		o c	- c	۷ -	o c	o c	> <	۱ c	- c
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		- +	- +	י כ	o c	o c	- +	- c	o c			- +	- c	o c	o c	י כ	- +	
4 rialice			- +	V C	.) T	- c	v c) T		.	- c	u =	.	o 0	N C	- •	.
			- +	o c	o c	- c	v c	o c	- +) -	۷ -	1 +	o c	o c	o c	- c	o c
			- +	и c	o c	o c	V T	ч с	- c		- c	- +	- c	o c	o c	и c	Vτ	o c
		_ ,	- ,	o 0	> 0	5 6	- ,	V T	5 6		5 6	- 0	V C	5 6	5 6	N C	- ,	> 0
		_ (- ,	N (-	-	- ,	- ,	-		-	-	N (-	-	N T	- (> (
	:	N ·)))		– ())	э,)))	- (э,)
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				Ν ())		N (o (o (2 ())	Ν (o (
13 Italy		_	-	2	0	0	.	2	0		0	-	3	0	0	2	1	0

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Appendix table 5-54.

Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

							Collabor	Collaborating country (by country code)	untry (by	country	(apoo						
								_	1991-95								
Code Country/region	20	72	22	23	24	25	26	27	78	59	33	32	33	34	36	37	38
14 Greece	2	2	2	0	-	0	2	0	-	0	-	2	0	0	-	2	0
15 Portugal	7	2	က	0	0	-	2	0	-	0	-	2	0	0	-	0	0
16 Spain	-	-	2	0	0	0	-	0	0	0	-	_	0	0	-	-	0
17 Turkey	-	0	-	0	-	0	-	0	0	0	0	2	-	0	2	0	0
19 Denmark	က	4	Ξ	-	0	-	2	-	0	0	-	2	0	0	2	-	0
20 Finland		က	10	0	0	7	2	0	-	0	2	4	0	_	က	-	0
21 Norway	က		12	-	0	-	2	-	-	0	_	2	0	0	2	-	0
22 Sweden	4	4		0	0	-	2	-	0	0	-	2	0	-	က	-	0
23 Iceland	2	ဝ	12		0	0	0	0	0	0	0	0	0	0	2	-	0
24 Bulgaria	-	0	7	0		7	က	7	-	0	œ	9	-	0	က	0	0
	က	-	က	0	-		-	-	0	0	7	7	0	0	က	-	0
	7	-	4	0	-	-		-	-	-	7	4	-	0	7	0	0
27 Czechoslovakia	-	-	က	0	_	7	4		-	0	10	က	0	0	7	0	0
28 Czech Republic	7	0	7	0	-	-	က	-		4	0	9	-	0	7	0	0
29 Slovakia	7	7	4	0	0	-	2	-	∞		0	7	0	0	7	-	0
31 USSR	7	-	က	0	က	7	4	2	0	0		0	0	0	7	-	0
32 Russia	7	-	က	0	-	-	က	-	-	-	0		2	-	က	-	0
	-	0	7	0	-	-	7	-	-	7	0	59		-	7	0	-
34 Baltic states	∞	7	14	0	_	0	က	0	-	0	0	16	7		-	0	0
36 Japan	-	0	7	0	0	-	-	0	0	0	0	7	0	0		4	-
37 China	-	0	7	0	0	-	-	0	0	0	0	-	0	0	Ξ		-
38 Taiwan	0	0	-	0	0	0	0	0	0	0	0	-	0	0	∞	က	
39 South Korea	0	0	-	0	0	0	-	0	0	0	0	7	0	0	19	7	-
40 Singapore	-	0	7	0	0	0	0	0	0	0	0	0	0	0	7	9	က
	0	0	7	0	0	0	0	0	0	0	0	0	0	0	က	20	4
42 India	-	0	-	0	0	-	-	0	0	0	-	_	0	0	2	-	0
44 Australia	0	0	က	0	0	0	_	0	0	0	0	_	0	0	4	8	0
45 New Zealand	-	-	7	0	0	0	-	0	0	0	0	0	0	0	4	-	0
46 Israel	0	0	-	0	0	0	-	0	0	0	-	5	0	0	7	0	0
48 Argentina	_	0	က	0	0	0	_	0	0	0	0	0	0	0	_	0	0
	-	-	-	0	0	0	-	0	-	0	0	2	0	0	က	-	0
_	0	0	7	0	0	0	-	0	0	0	0	0	0	0	-	-	0
52 Mexico	0	0	-	0	0	0	-	0	0	0	0	က	-	0	-	-	0
	_	0	_	0	0	-	_	0	0	0	-	_	0	0	4	-	0
56 South Africa	-	0	-	0	0	0	2	0	0	0	0	-	0	0	7	0	-
0																	

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Appendix table 5-54. Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

						Collabo	Collaborating country (by country code)	ountry (b	y count	ry code)				
								1991-95						
Code	Code Country/region	39	40	41	45	4	45	46	48	49	20	25	54	26
	Articles (thousands)	11.5	3.9	5.1	43.8	52.2	10.4	25.6	8.3	15.7	4.5	7.2	6.7	10.9
	International (%)	78 78	5 5 7	35	3 8	24	8 8	37	31	3 4	3	4 4	27	22
_	United States	-	0	0	-	က	-	4	-	2	-	-	0	-
8	Canada	0	0	0	-	က	-	-	0	_	0	0	0	0
က	_	0	0	-	-	4	-	-	0	-	0	0	0	-
4	France	0	0	0	-	-	0	-	-	7	0	-	0	0
2	_	0	0	0	-	7	0	7	0	-	0	0	0	-
9	Austria	0	0	0	-	-	0	-	0	0	0	0	-	-
7	_	0	0	0	-	-	0	-	0	-	0	0	0	0
∞		0	0	0	0	-	0	-	0	0	0	0	0	0
0	_	0	0	0	-	0	0	0	0	-	0	0	0	0
9		0	0	0	-	-	0	-	0	0	0	0	0	0
Ξ		0	0	0	-	-	0	-	0	_	0	0	0	0
13		0	0	0	-	-	0	-	0	_	0	0	0	0
14		0	0	0	0	0	0	-	0	_	0	0	0	0
15		0	0	0	0	0	0	-	0	4	0	0	0	0
16		0	0	0	_	-	0	-	7	_	_	-	0	0
17	Turkey	0	0	0	0	0	0	7	0	0	0	0	-	0
19		0	0	0	0	-	0	-	0	0	0	0	0	0
20	Finland	0	0	0	0	-	0	-	0	_	0	0	0	0
2	_	0	0	0	0	-	0	-	0	-	0	0	0	0
22	٠,	0	0	0	0	7	0	-	0	-	0	0	0	0
23		0	0	0	0	-	0	-	0	0	0	0	0	0
24	_	0	0	0	-	-	0	-	0	0	0	0	0	0
52	_	0	0	0	-	-	0	-	0	0	0	0	0	0
56	_	0	0	0	0	-	0	-	0	-	0	0	0	0
27	Czechoslovakia	0	0	0	-	0	0	0	0	-	0	0	0	0
78	Czech Republic	0	0	0	0	-	0	-	0	2	0	-	0	0
53	0)	0	0	0	-	-	0	0	0	_	0	0	0	0
સ	USSR	0	0	0	-	-	0	-	0	0	0	0	0	0
35	Russia	-	0	0	-	-	0	2	0	_	0	-	0	0
33	Ukraine	0	0	0	0	0	0	0	0	-	0	-	0	0
34	Baltic states	0	0	0	0	0	0	-	0	0	0	0	0	0
36	Japan	7	0	0	-	7	0	-	0	-	0	0	0	0

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Appendix table 5-54. Patterns of international coauthorship in scientific and technical research: 1981-85 and 1991-95 (Percentages)

					O	Collaborating country (by country code)	ting cou	ntry (by	country	(apoc				
							16	1991-95						
Code	Code Country/region	39	40	14	42	44	45	46	48	49	20	52	54	26
37	China	-	-	4	1	က	0	0	0	-	0	0	0	0
88	Taiwan	_	-	က	-	_	0	-	0	0	0	0	0	-
33	South Korea		0	0	-	_	0	0	0	-	0	0	0	0
4	Singapore	0		7	2	10	-	0	0	-	0	0	0	0
4	Hong Kong	0	-		-	2	-	0	0	-	0	0	0	0
45	India	0	0	0		7	0	0	0	-	0	-	0	0
4	Australia	0	-	-	-		4	-	0	-	0	0	0	-
45	New Zealand	0	0	-	-	17		-	0	0	0	0	0	-
46	Israel	0	0	0	0	-	0		0	-	0	0	0	-
48	Argentina	0	0	0	0	-	0	-		ω	က	7	0	-
49	Brazil	0	0	0	-	_	0	-	က		_	_	0	-
20	Chile	0	0	0	-	-	0	-	4	4		7	0	-
25	Mexico	0	0	0	-	-	0	_	-	က	7		0	0
24	Egypt	0	0	0	-	0	0	0	0	0	0	0		0
26	South Africa	0	0	0	-	0	2	-	4	-	-	-	0	

NOTES: Listed countries received at least 0.3 percent of all citations for all natural science and engineering fields combined. Hong Kong data were included with United Kingdom through 1986. Details may not add to totals because of rounding.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research, Inc., Science Indicators database; and National Science Foundation, unpublished tabulations. Science & Engineering Indicators – 1998

See figure 5-28.

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Appendix table 5-55.

Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

													5	(aboo vatarioo vd) bayiaoay saoitati	2001	Davie	1 2	1 4		[[1
Code Country/region	-	7	က	4	2	9	7	∞	စ	우	=	12	13	14	15 1	16 1	17 18	8 19	20	2	22	23	24	52	56	27	88	53	30	3	32	33
										M∃ng	natural	Science	nce a	and er	ngine	ering	engineering fields	<u>_v</u>														l
1 United States	67	က		က	4	0	-	2	-	-	-	0	-	0		_		0				0	0	0	0	0	0	-	0	0	0	0
2 Canada	42	25		က	4	0	-	7	-	7	-	0	_		0			0				0	0	0	0	0	0	7	0	0	0	0
3 United Kingdom	37	က		4	2	0	-	7	7	7	-	-	_		0	7		0				0	0	0	0	0	0	7	0	0	0	-
4 France	38	က		24	9	0	-	7	7	7	-	-	_	0	0			0				0	0	0	0	0	0	-	0	0	0	_
5 Germany	37	က		4	27	-	-	7	7	7	-	0	_	_	0	_		_	_			0	0	0	0	0	0	-	0	0	0	0
-	. 38	က		4	6	15	-	7	7	7	-	-	_	_				-				0	0	0	0	0	0	-	0	0	0	-
7 Belgium	37	က	∞	9	9	0	17	က	7	7	-	-	_	_	0	2	0	0		0 0	2	0	0	0	0	0	0	-	0	0	0	_
		က		4	9	0	-	2	7	7	-	0	_	_				0				0	0	0	0	0	0	-	0	0	0	0
9 Switzerland	42	က		4	œ	-	_	7	16	က	-	0	_	_				0				0	0	0	0	0	0	-	0	0	0	_
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14 Finland	37	4		က	2	-	-	7	7	7	-	0	-	50		4		-	_	0		0	0	0	0	0	0	7	0	0	0	0
15 Norway		4		က	2	0	-	က	-	7	-	-	7	-	6			0	_			0	0	0	0	0	0	-	0	0	0	-
16 Sweden		က		က	2	0	_	7	-	7	-	0	7	_				0					0	0	0	0	0	-	0	0	0	0
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Appendix table 5-55. Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

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4	Finland	39	က	6	က	4	-	-	7	-	2			_					_	0	0	4	0	0	0	0	0	0	7	0	0		$\overline{}$
15	Norway	37	4	6	က	4	-	-	က	7	7	_	-	2	1 2	8 5	0	0	-	0	0	4	0	0	0	0	0	0	7	0	0		_
	Sweden	37	က	6	က	4	-	-	7	-	7								-	0	0	4	0	0	0	0	0	0	_	0	0		$\overline{}$
	Poland	38	က	6	4	7	-	-	7	7	4						_		_	0	0	2	0	0	0	0	0	_	_	_	0		$\overline{}$
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20	Russia	42	2	6	2	2	-	-	က	7	က	-	· -	·-					-	6	0	4	0	0	0	0	0	0	7	0	0		$\overline{}$
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Appendix table 5-55.

Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

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3 United Kingdom		က		4	9	0	_	7	7	_	_	0	-	0	0	-	0	_	0	0	2	0	0	0	0	0	0	-	0	0	0	0
4 France		က		22	2	0	_	7	7	7	_	0	_						0	0	2	0	0	0	0	0	0	-	0	0	0	0
5 Germany		က		4	24	-	-	7	7	-	_	0	_					_	0	0	2	0	0	0	0	0	0	-	0	0	0	0
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10 Italy	42	က		4	2	-	-	7		19	_	0		-				_	0	0	2	0	0	0	0	0	0	-	0	0	0	0
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Appendix table 5-55.

Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

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Appendix table 5-55.

Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

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Appendix table 5-55. Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

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Appendix table 5-55.

Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

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Appendix table 5-55.

Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

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Appendix table 5-55. Selected countries' citations to the international scientific and technical literature: 1995 articles citing 1991-93 publications (Percentages)

													Õ	itatior	Citations received (by country code)	eived	(by c	count	y coc	de)												
Code Country/region	1	2	3	4	2	9	7	8	6	10	1	12	. 21	14	15 1	16 1	17 1	18 1	6	20 21	1 22	2 23	3 24	25	26	27	28	29	30	31	32	33
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1 United States		က	4	4	က	0	0	-	-	-	-	-	-	0	0	-	0	_	_								0	_	0	_	0	0
2 Canada		33	9	က	4	_	0	-	-	7	-	-	_	0	_	0	0	0	_								0	7	_	0	0	0
3 United Kingdom		က	40	က	4	0	0	-	7	-	0	-	_	0	0	0	0	0	_								0	7	0	_	0	-
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8 Netherlands		2	က	4	9	_	7	34	_	က	-	7	0	0	_	_	0	_	_								_	က	0	7	-	0
9 Switzerland	32	က	6	က	7	0	0	0	23	က	က	0	7	0	0	7	0	7	_								0	7	0	_	-	0
10 Italy	35	12	24	က	2	7	0	-	4	-	-	-	_	0	0	0	0	0	_								0	7	0	_	0	0
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12 Other W./S.																																
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13 Denmark		7	က	_	က	0	_	က	0	-	0	0															0	0	0	0	0	0
14 Finland	. 25	∞	9	10	9	7	7	7	0	0	0	0															0	4	0	9	0	0
15 Norway		9	7	_	က	0	0	-	0	-	0	-															_	က	0	0	0	0
16 Sweden		က	က	4	9	0	0	0	0	7	-	-			•												0	7	_	0	0	0
17 Poland	. 29	7	2	9	7	က	0	-	7	-	0	-	0	0	_	-	65	_	_	0	0	2	0 0	_	0	0	0	7	_	_	4	-
18 Other E. Europe	23	9	7	∞	∞	_	7	7	7	4	4	-					• •										0	_	0	_	0	-
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		0	က	က	9	0	0	9	0	0	0	0	0	0	0	0	0	0	0					_			0			0	0	0
26 Singapore		0	9	0	10	0	0	0	0	0	0	0	0	0	7	0	N	0	0						•		0			N	0	0
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33 All other countries		2	က	ω	7	0	0	-	0	2	-	0	-	-	0	0	0	_	က								N	7	_	0	0	23

NOTE: Listed countries received at least 0.3 percent of all citations for all natural science and engineering fields combined.

SOURCES: Institute for Scientific Information, Science Citation Index; CHI Research, Inc., Science Indicators database; and National Science Foundation, unpublished tabulations.

See figure 5-29.

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Appendix table 5-56. Citations on U.S. patents to the U.S. scientific and technical literature, by field and cited sector: 1988-96

Citing year and cited sector	Total	Clinical medicine	Biomedical research	Biology	Chemistry	Physics	Earth & space sciences	Engineering & technology	Mathe- matics
			Number o	f citations					
1988 – Total U.S	9,495	2,423	2,749	220	1,212	1,595	81	1,211	2
Academia	4,695	1,309	1,654	148	703	465	40	372	1
Industry	2,465	254	323	22	353	804	16	690	1
Federal Government	961	326	303	42	70	128	12	77	0
FFRDCs	340	18	44	0	46	179	5	46	0
Nonprofits	908	457	375	5	34	13	1	21	0
Other	123	57	48	2	3	4	5	3	0
1990 – Total U.S	12,906	3,417	3,818	306	1,673	2,169	76	1,443	3
Academia	6,436	,	,	201	939	727	30	463	2
	,	1,853	2,218						0
Industry	3,448	408	558 405	30	571 56	1,068	27	783 76	_
Federal Government	1,188	422	405	64	56	154	9	76	0
FFRDCs	418	27	55 547	1	50	189	4	88	1
Nonprofits	1,240	618	517	5	50	25	4	19	0
Other	174	86	62	3	4	3	0	12	0
1992 – Total U.S	19,404	5,294	6,949	436	2,451	2,667	92	1,494	18
Academia	9,982	2,855	3,829	294	1,513	905	47	528	8
Industry	4,552	664	1,053	53	683	1,294	25	769	7
Federal Government	1,898	642	862	63	105	151	8	62	2
FFRDCs	592	41	110	1	88	257	6	85	1
Nonprofits	2,068	948	967	11	57	46	1	36	0
Other	312	144	128	14	5	14	5	14	0
									- 11
1994—Total U.S	27,422	7,223	10,334	675	3,114	3,589	121	2,349	14
Academia	14,535	3,989	5,852	453	1,968	1,258	53	947	11
Industry	6,443	936	1,713	94	839	1,710	35	1,111	1
Federal Government	2,519	907	1,087	96	98	200	16	113	0
FFRDCs	808	74	150	4	114	338	4	121	1
Nonprofits	2,727	1,131	1,372	19	84	73	4	42	0
Other	390	186	160	9	11	10	9	15	1
1996-Total U.S	47,059	13,630	20,617	1,344	4,533	3,498	193	3,215	25
Academia	25,814	7,451	11,565	922	2,951	1,384	101	1,421	14
Industry	9,713	1,856	3,392	180	1,099	1,634	57	1,481	9
Federal Government	4,466	1,674	2,139	181	165	162	17	124	1
FFRDCs	958	114	305	9	139	264	10	114	0
Nonprofits	5,353	2,173	2,897	35	153	45	6	42	1
Other	755	362	319	17	26	9	2	33	Ö
<u> </u>					sector (perce				
1000 7 : 1110									
1988—Total U.S	100	26	29	2	13	17	1	13	0
Academia	100	28	35	3	15	10	1	8	0
Industry	100	10	13	1	14	33	1	28	0
Federal Government	100	34	32	4	7	13	1	8	0
FFRDCs	100	5	13	0	14	53	1	14	0
Nonprofits	100	50	41	1	4	1	0	2	0
Other	100	46	39	2	2	3	4	2	0
1990 - Total U.S	100	26	30	2	13	17	1	11	0
Academia	100	29	34	3	15	11	0	7	0
Industry	100	12	16	1	17	31	1	23	0
Federal Government	100	36	34	5	5	13	1	6	0
FFRDCs	100	6	13	0	12	45	1	21	0
	100	50		0	4		0		0
Nonprofits			42			2	_	2	-
Other	100	49	36	2	2	2	0	7	0

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Appendix table 5-56. Citations on U.S. patents to the U.S. scientific and technical literature, by field and cited sector: 1988-96

Citing year and cited sector	Total	Clinical medicine	Biomedical research	Biology	Chemistry	Physics	Earth & space sciences	Engineering & technology	Mathe- matics
1992—Total U.S	100	27	36	2	13	14	0	8	0
Academia	100	29	38	3	15	9	0	5	0
Industry	100	15	23	1	15	28	1	17	0
Federal Government	100	34	45	3	6	8	0	3	0
FFRDCs	100	7	19	0	15	43	1	14	0
Nonprofits	100	46	47	1	3	2	0	2	0
Other	100	46	41	4	2	4	2	4	0
1994 – Total U.S	100	26	38	2	11	13	0	9	0
Academia	100	27	40	3	14	9	0	7	0
Industry	100	15	27	1	13	27	1	17	0
Federal Government	100	36	43	4	4	8	1	4	0
FFRDCs	100	9	19	0	14	42	0	15	0
Nonprofits	100	41	50	1	3	3	0	2	0
Other	100	48	41	2	3	3	2	4	0
								•	_
1996 – Total U.S	100	29	44	3	10	7	0	7	0
Academia	100	29	45	4	11	5	0	6	0
Industry	100	19	35	2	11	17	1	15	0
Federal Government	100	37	48	4	4	4	0	3	0
FFRDCs	100	12	32	1	15	28	1	12	0
Nonprofits	100	41	54	1	3	1	0	1	0
Other	100	48	42	2	3	1	0	4	0
1988 – Total U.S	100	100	100	100	100	100	100	100	100
Academia	49	54	60	67	58	29	49	31	50
Industry	26	10	12	10	29	50	20	57	50
Federal Government	10	13	11	19	6	8	15	6	0
FFRDCs	4	1	2	0	4	11	6	4	0
Nonprofits	10	19	14	2	3	1	1	2	0
Other	1	2	2	1	0	0	6	0	0
1990 - Total U.S	100	100	100	100	100	100	100	100	100
Academia	50	54	58	66	56	34	39	32	67
Industry	27	12	15	10	34	49	36	54	0
Federal Government	9	12	11	21	3	7	12	5	0
FFRDCs	3	1	1	0	3	9	5	6	33
Nonprofits	10	18	14	2	3	1	5	1	0
Other	1	3	2	1	0	0	0	1	0
1992 – Total U.S	100	100	100	100	100	100	100	100	100
Academia	51	54	55	67	62	34	51	35	44
Industry	23	13	15	12	28	49	27	51	39
Federal Government	10	12	12	14	4	6	9	4	11
FFRDCs	3	1	2	0	4	10	7	6	6
Nonprofits	11	18	14	3	2	2	1	2	0
Other	2	3	2	3	0	1	5	1	0
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Appendix table 5-56. Citations on U.S. patents to the U.S. scientific and technical literature, by field and cited sector: 1988-96

Citing year and cited sector	Total	Clinical medicine	Biomedical research	Biology	Chemistry	Physics	Earth & space sciences	Engineering & technology	Mathe- matics
1994—Total U.S	100	100	100	100	100	100	100	100	100
Academia	53	55	57	67	63	35	44	40	79
Industry	23	13	17	14	27	48	29	47	7
Federal Government	9	13	11	14	3	6	13	5	0
FFRDCs	3	1	1	1	4	9	3	5	7
Nonprofits	10	16	13	3	3	2	3	2	0
Other	1	3	2	1	0	0	7	1	7
1996 - Total U.S	100	100	100	100	100	100	100	100	100
Academia	55	55	56	69	65	40	52	44	56
Industry	21	14	16	13	24	47	30	46	36
Federal Government	9	12	10	13	4	5	9	4	4
FFRDCs	2	1	1	1	3	8	5	4	0
Nonprofits	11	16	14	3	3	1	3	1	4
Other	2	3	2	1	1	0	1	1	0

FFRDC = federally funded research and development center

NOTE: Percentages may not total 100 because of rounding.

SOURCES: CHI Research, Inc., U.S. Patent and Citation Indicators database; and National Science Foundation, unpublished tabulations.

See figure 5-30 and text table 5-13.

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Appendix table 5-57. U.S. universities and colleges with largest 1995 R&D volume and to other academic institutions: 1982-95

Institution	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
					Number of	f patents								
All academic institutions ^a	458	434	551	588	029	819	813	1225	1176	1331	1533	1607	1762	1860
Public	241	224	259	307	357	396	407	655	029	794	806	940	1067	1190
Private	217	210	292	281	313	423	406	220	909	537	625	299	695	029
Top 100 in 1995 R&D ^b	354	334	407	449	510	662	999	1003	975	1108	1291	1351	1483	1561
Public	203	191	217	262	300	344	353	229	571	671	922	802	912	1022
Private	151	143	190	187	210	318	312	444	404	437	515	546	571	539
Percent of all patents awarded	77	77	74	9/	9/	81	82	85	83	83	84	84	84	84
			Numb	er of acad	Number of academic institutions		awarded pat	patents						
All academic institutions ^a	73	83	102	113	121	124	122	153	147	154	152	163	167	168
Public	43	25	26	64	75	20	20	06	87	94	93	101	101	103
Private	30	31	46	49	46	54	52	63	09	09	29	62	99	65
Top 100 in 1995 R&D [▷]	51	26	64	71	74	77	9/	83	84	82	83	82	87	98
Public	30	32	38	45	48	48	47	25	54	26	54	22	26	22
Private	21	73	56	56	56	59	59	31	30	59	59	30	31	31
					Top 100-	-public								
Arizona State University	0	0	-	-	-	2	0	6	6	12	9	2	ო	9
Auburn University	0	0	0	-	-	0	0	0	0	· —	2	0	8	2
Clemson University	C	C	α.	~	-	m	c	C	ထ	~	9	4	10	œ
Colorado State University	0	0	0	ı -	. ო	4	0 0	0	0	ı 4	-	4	. —	· -
Florida State University	0	0	-	0	2	2	-	-	-	-	7	6	2	10
Georgia Institute of Technology	00	က	9	Ξ	ര	6	7	œ	18	Ξ	16	16	20	21
Indiana University	0	က	7	4	0	က	-	9	-	က	9	-	7	9
Iowa State University	15	9	14	21	6	15	15	28	30	33	23	59	37	37
Louisiana State University	0	-	-	-	-	က	4	6	4	2	20	16	Ξ	14
Michigan State University	-	က	က	က	10	9	80	2	7	Ξ	19	13	21	15
New Mexico State University	0	7	0	0	_	2	0	0	0	_	0	7	4	0
North Carolina State University	-	0	2	က	4	9	2	10	14	Ξ	24	27	32	31
Ohio State University	9	တ	က	12	2	13	4	13	10	15	21	10	10	17
Oklahoma State University	0	0	0	0	7	0	7	-	-	-	7	0	0	က
Oregon State University	0	-	0	7	က	0	7	-	-	9	တ	2	Ξ	9
Pennsylvania State University	0	0	0	0	0	0	0	-	_	-	0	4	Ξ	16
Purdue University	Ξ	Ξ	14	18	တ	4	7	Ξ	15	Ξ	2	9	Ξ	10
Rutgers University	0	0	-	-	0	7	7	7	7	15	12	15	18	20
SUNY	ω	7	Ξ	2	Ξ	18	10	22	50	27	34	30	37	31
Texas A&M University	က	7	က	œ	က	9	တ	80	တ	12	14	22	50	16
University of Alabama	က	-	-	2	က	2	က	က	9	က	7	9	7	6
University of Arizona	-	7	-	7	7	0	0	-	7	-	-	4	6	10
University of California	42	48	46	42	54	29	09	81	92	84	81	115	163	213
University of Cincinnati	0	0	7	7	-	∞	က	80	6	တ	7	œ	7	∞
University of Colorado	0	0	0	0	0	-	0	က	6	9	19	7	14	18
Dozo 1 of 7														

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Appendix table 5-57. U.S. universities and colleges with largest 1995 R&D volume and to other academic institutions: 1982-95

Institution	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
					Top 100-	- public								
University of Connecticut	0	0	0	-	-	2	-	2	œ	က	о	6	2	80
University of Florida	0	9	9	7	10	13	21	33	33	38	4	34	56	31
University of Georgia	0	7	7	2	9	က	0	က	Ŋ	œ	10	18	7	10
University of Hawaii	-	-	0	7	0	-	က	2	9	7	2	80	9	7
University of Health Sciences/Chicago	0	0	0	0	5	-	-	_	0	0	0	-	0	0
University of Illinois	7	œ	œ	10	12	4	6	15	7	œ	10	13	14	12
University of Iowa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
University of Kansas	0	7	7	-	0	2	0	-	က	4	7	က	7	7
University of Kentucky	9	9	7	2	7	4	7	9	4	7	7	4	က	7
University of Maryland	0	-	0	0	က	2	2	-	4	4	4	21	15	20
University of Massachusetts	0	0	-	-	0	2	-	က	က	9	2	4	2	12
Univ. of Medicine & Dentistry of NJ	-	-	0	-	4	7	2	4	7	2	9	-	4	2
University of Michigan	7	2	-	-	10	9	4	23	27	21	21	19	28	30
University of Minnesota	10	2	9	Ξ	16	28	56	40	38	32	31	27	28	25
University of Missouri	ဝ	2	4	0	က	œ	6	2	9	7	တ	œ	7	10
University of Nebraska	4	0	2	-	-	-	4	0	က	4	4	10	16	21
University of New Mexico	0	0	0	2	က	-	က	6	တ	10	Ξ	2	6	15
University of North Carolina	0	-	0	0	က	5	5	9	œ	က	Ξ	14	13	21
University of Oklahoma	7	-	7	2	5	7	9	4	7	က	7	14	œ	Ξ
University of Pittsburgh	7	2	œ	က	80	10	9	=	Ξ	16	10	10	10	13
University of South Carolina	-	0	7	-	-	0	4	7	0	4	9	5	က	0
University of South Florida	0	0	0	0	-	0	0	7	7	7	2	7	4	9
University of Tennessee	-	0	-	2	80	80	80	12	14	10	12	4	2	14
University of Texas	7	2	∞	19	22	21	21	20	54	83	73	98	26	83
Univ. of Texas Anderson Cancer Ctr	0	0	0	0	0	0	0	0	0	0	0	0	-	0
Univ. of TX SW Medical Ctr. Dallas	0	0	0	0	0	0	0	0	0	0	0	0	0	-
University of Utah	14	15	တ	Ξ	7	12	6	13	14	2	13	20	22	17
University of Virginia	∞	4	7	-	4	က	4	∞	12	Ξ	တ	7	2	10
University of Washington	7	7	က	-	2	-	9	2	7	Ξ	12	Ξ	13	17
University of Wisconsin	17	13	16	17	17	Ξ	20	27	16	44	42	26	48	47
Utah State University	0	0	-	က	2	5	-	-	7	က	7	7	7	8
Virginia Commonwealth University	0	0	0	0	0	0	0	0	-	-	က	9	4	7
Virginia Polytechnic Institute	0	0	0	0	0	0	5	7	4	F	18	12	16	9
Washington State University	က	7	0	7	5	7	-	2	က	က	က	7	4	4
Wayne State University	7	-	0	-	2	9	7	16	6	œ	16	12	14	6
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Appendix table 5-57 U.S. universities and colleges with largest 1995 R&D volume and to other academic institutions: 1982-95

Institution	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
					Top 100-	-private								
Baylor College of Medicine	က	-	2	2	2	7	က	7	8	4	9	6	6	4
Boston University	-	7	7	က	9	6	တ	တ	Ξ	9	22	15	14	14
California Institute of Technology	19	16	15	16	23	27	18	26	30	36	35	59	46	38
Carnegie-Mellon University	0	0	က	က	က	-	7	2	က	2	10	4	∞	10
Case Western Reserve University	0	0	-	-	9	က	-	-	7	-	6	9	∞	œ
Columbia University	0	7	က	4	7	9	15	19	16	œ	17	17	18	18
Cornell University	9	10	4	50	13	30	16	22	34	40	41	32	33	36
Duke University	က	က	9	4	9	4	တ	Ξ	7	9	တ	12	58	20
Emory University	0	0	0	-	-	0	0	7	က	10	9	14	2	7
Georgetown University	-	4	2	-	0	4	က	-	2	က	2	2	7	9
Harvard University	Ξ	10	7	-	7	6	17	15	23	6	16	17	16	4
Johns Hopkins University	80	9	10	15	18	18	21	27	15	25	20	33	23	28
Massachusetts Inst. of Technology	51	47	47	35	45	63	64	101	109	101	125	112	66	104
Mount Sinai School of Medicine	4	က	2	-	7	-	7	-	7	2	က	က	4	4
New York University	7	က	4	2	ო	2	4	9	4	œ	Ξ	19	16	15
Northwestern University	7	က	2	2	80	10	10	7	2	4	œ	∞	12	18
Princeton University	0	0	0	0	0	2	-	12	4	13	4	Ξ	7	12
Rockefeller University	က	-	က	2	4	6	Ξ	9	80	14	23	23	13	တ
Stanford University	4	16	36	38	33	48	24	43	36	22	45	20	62	54
Tufts University	0	0	0	0	0	-	7	7	-	2	7	6	9	က
Tulane University	0	0	-	7	-	-	က	4	4	7	2	9	9	2
University of Chicago	5	0	5	0	0	-	9	7	7	0	0	9	14	16
University of Miami	5	0	4	4	ო	15	2	2	-	-	2	2	2	2
University of Pennsylvania	_	7	4	2	-	7	-	6	19	18	56	34	37	25
University of Rochester	80	တ	9	7	∞	တ	Ξ	Ξ	13	12	9	Ξ	10	9
University of Southern California	2	-	7	2	2	4	7	œ	9	2	18	13	15	9
Vanderbilt University	5	-	0	0	2	4	4	4	2	7	4	7	9	6
Washington University	0	-	-	က	-	7	9	12	7	22	18	9	19	21
Woods Hole Oceanographic Inst	0	0	0	0	0	0	0	-	0	-	0	0	7	-
Yale University	0	2	2	2	3	12	9	11	10	4	12	14	13	16
				Ö	Other public	public institutions	SI							
Ball State University	0	0	0	0	0	0	0	0	0	0	0	-	0	0
Bowling Green State University	0	0	0	-	0	0	-	-	-	0	0	0	0	0
California Polytechnic State Univ	0	0	0	0	0	0	0	0	0	0	0	0	0	-
California State University Fresno	0	0	0	0	0	0	0	0	0	0	0	-	0	က
California State University Fullerton	0	0	0	0	0	0	0	-	0	0	0	0	0	0
City College of New York	0	0	0	0	0	0	0	0	0	0	-	0	-	-
City University of New York	0	0	0	0	0	0	-	-	0	0	0	0	0	-
Cleveland State University	0	0	0	0	0	0	0	0	0	0	က	4	က	0
College of Forestry, Wildlife & Range														
Sciences, Univ. of Idaho	0	-	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix table 5-57. U.S. universities and colleges with largest 1995 R&D volume and to other academic institutions: 1982-95

:				1000		1								100
Institution	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Colorado School of Mines	0	0	0	2	-	0	0	2	2	2	2	٦	-	2
East Carolina University	0	0	0	0	0	0	0	0	-	-	-	-	-	-
East Tennessee State University	0	0	0	0	0	-	0	0	0	0	0	0	0	0
Eastern Washington University	0	0	0	0	0	0	0	0	0	0	0	0	0	-
Florida Agricultural & Mechanical Univ	0	0	0	0	_	0	-	0	0	0	0	0	0	0
Florida Atlantic University	0	0	0	0	0	0	0	0	0	-	0	က	က	-
Florida International University	0	0	0	0	0	0	0	0	2	0	_	-	0	0
Fort Valley State College	0	0	0	0	0	0	0	-	0	0	0	0	0	0
Georgia State University	0	0	0	0	0	0	0	0	2	0	_	-	8	-
Grand Valley State University	0	0	0	0	0	0	0	0	0	0	0	0	0	-
Hahnemann University	0	0	2	0	0	0	0	0	0	0	2	-	0	0
Illinois State University	0	0	0	0	0	0	0	2	-	0	_	0	0	0
James Madison University	0	0	0	0	0	0	0	0	0	0	0	0	-	0
Kansas State University	7	4	က	2	4	4	က	4	-	7	7	တ	20	1
Kent State University	0	0	0	0	0	-	0	0	-	က	7	က	က	4
Medical College of Georgia	0	-	-	-	0	0	0	0	0	0	0	0	0	0
Medical College of Ohio	0	-	0	2	0	4	-	0	-	7	0	0	0	2
Medical University of South Carolina	0	0	0	0	_	0	-	0	-	0	0	0	-	2
Memphis State University	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Miami University	0	-	0	0	0	0	2	0	0	0	0	0	0	0
Michigan Technological University	7	4	7	9	2	-	7	-	2	9	9	က	က	2
Mississippi State University	0	0	0	0	0	0	0	0	0	0	0	-	-	2
Montana State University	က	7	7	-	-	0	0	-	က	7	-	0	4	7
Montclair State College	0	0	0	0	0	0	0	0	-	0	0	0	0	0
New Jersey Institute of Technology	0	0	0	-	0	0	0	2	0	-	2	0	-	7
New Mexico Inst. of Mining & Tech	0	0	0	0	7	-	0	0	0	0	-	0	က	5
North Carolina Central University	0	0	0	_	0	0	0	0	0	7	0	-	0	0
North Dakota State University	0	0	5	0	0	0	0	2	0	2	2	က	-	2
Northeast University of Technology	0	0	0	0	0	0	0	-	0	0	0	0	0	0
Northeastern Ohio Universities														
College of Medicine	0	0	0	0	0	0	0	0	0	0	0	-	0	-
Northern Illinois University	0	0	0	0	0	0	-	0	0	-	0	7	7	-
Nova University	0	0	0	0	-	0	0	0	0	0	0	0	0	0
Oak Ridge Associated Universities	0	0	0	0	0	0	-	7	0	0	-	0	0	0
Ohio University	0	0	0	0	-	-	0	-	0	4	က	က	က	2
Old Dominion University	0	0	0	0	0	0	0	0	0	0	0	-	7	0
Oregon Health Sciences University	0	0	0	0	0	ო	0	က	4	9	2	2	9	10
Pennsylvania Research Corporation	0	0	0	0	0	-	-	0	7	2	7	9	2	7
Portland State University	0	0	-	0	-	-	0	0	0	0	0	0	0	0
Saginaw Valley State University	0	0	0	0	0	0	-	-	0	-	0	0	-	0
South Dakota School of Mines	0	0	0	-	0	0	0	0	0	0	-	0	2	0
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Appendix table 5-57. U.S. universities and colleges with largest 1995 R&D volume and to other academic institutions: 1982-95

Institution	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Southeastern Illinois College	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Temple University	2	0	2	0	-	2	7	10	တ	က	14	6	6	Ξ
Texas Tech University	0	0	0	0	2	-	2	0	0	_	_	0	0	-
University of Iowa	2	က	4	-	œ	œ	9	80	12	9	7	Ξ	<u></u>	17
University of Akron	4	-	က	က	7	0	9	9	တ	14	Ξ	6	17	Ξ
University of Alaska	0	0	0	0	0	0	0	0	0	-	-	-	က	5
University of Arkansas	0	0	0	0	-	-	-	7	က	10	16	80	9	2
University of Central Florida	0	0	0	0	0	0	0	-	0	0	0	4	4	9
University of Delaware	12	9	2	တ	7	2	œ	œ	Ξ	10	10	2	4	2
University of Houston	0	0	0	0	-	0	0	က	က	4	-	က	2	80
University of Louisville	0	0	0	0	0	0	0	0	-	0	0	-	-	2
University of Lowell	0	0	0	0	0	0	0	7	-	2	က	-	-	0
University of Maine	7	7	7	က	-	0	0	-	-	0	0	0	0	0
Univ. of Maryland Eastern Shore	0	0	0	0	0	0	0	0	0	0	0	0	0	-
University of Minneapolis	0	0	0	0	0	0	0	0	0	0	0	-	0	0
University of Mississippi	-	0	-	0	0	-	0	7	0	0	-	2	0	5
University of Montana	0	0	0	0	-	0	0	0	0	0	0	-	-	5
University of Nevada	0	0	0	0	0	0	0	0	0	0	_	0	-	0
University of New Hampshire	0	0	0	0	-	0	0	-	0	-	0	0	-	0
University of New Orleans	0	0	0	0	0	0	0	0	0	0	0	0	-	0
University of North Dakota	0	0	0	0	0	0	0	0	က	4	_	7	_	-
University of Northern Iowa	0	0	-	0	-	0	0	0	0	0	0	-	0	0
University of Oregon	0	-	0	0	0	0	0	5	0	0	က	2	က	2
University of Puerto Rico	0	0	0	0	0	0	0	0	0	-	0	-	0	4
University of Rhode Island	0	-	5	7	7	7	က	4	က	က	0	0	0	0
University of South Alabama	0	0	0	-	က	0	0	5	0	-	0	4	2	-
University of Southern Illinois	0	0	-	0	0	0	-	_	7	-	_	-	0	0
University of Southern Mississippi	0	7	0	0	က	က	-	-	က	4	-	2	0	-
University of Southwestern Louisiana	0	0	0	0	-	0	0	7	-	0	0	0	0	0
University of Toledo	7	-	5	0	_	0	0	က	0	5	4	7	9	14
University of Vermont	0	0	0	0	0	-	-	4	4	5	4	-	-	-
University of Wisconsin-Milwaukee	0	0	0	0	0	0	0	0	0	-	-	-	0	-
University of Wyoming	0	0	0	0	0	-	0	0	0	0	0	0	0	2
West Virginia University	0	0	0	-	0	7	0	7	-	-	0	0	-	2
Western Kentucky University	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Western Michigan University	-	0	0	0	0	0	0	0	0	5	0	-	-	0
Western Washington University	0	-	0	0	0	0	0	0	0	0	0	0	0	0
Wichita State University	0	0	0	0	0	0	0	0	-	0	0	0	0	0
Wright State University	-	-	-	9	9	4	2	က	က	က	-	4	က	0

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Appendix table 5-57. U.S. universities and colleges with largest 1995 R&D volume and to other academic institutions: 1982-95

Institution	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
				₽	Other private	institutions	St							
Adelphi University	-	c	С	c	С	С	c	С	c	c	c	С	c	c
llege		· C) C	· C) C		· C	· -	· -	· C	· C	· -	· C	· C
Alfred University	· C	· -	ı.c	· 67	· -	· -		-	ေဖ	ı ıçı	ı rc	ေထ	4	· m
Ambassador College	0	0	0	0	0	0	0	-	-	-	0	-	0	0
American University	0	0	-	0	0	0	0	0	0	0	0	0	0	0
Baylor University	0	-	0	-	0	0	0	-	0	2	က	2	7	က
Boston College	0	0	0	0	0	0	0	0	0	0	-	0	0	0
Brandeis University	0	0	-	0	0	-	-	6	4	2	4	2	2	က
Brigham Young University	0	-	က	က	9	2	-	œ	6	2	6	13	က	က
Brooklyn College Foundation	0	0	0	0	0	0	0	0	0	0	0	-	-	0
Brown University	0	0	-	2	2	-	က	က	က	4	2	_	4	9
Catholic University of America	0	0	0	0	0	0	0	0	0	0	0	-	က	4
Chapman College	0	0	0	0	0	0	-	0	0	0	0	0	0	0
Clark University	0	0	0	0	0	0	0	0	0	0	0	0	0	-
Clarkson University	0	0	0	0	0	0	0	0	0	-	0	0	-	0
College of Aeronautics, Brooklyn	0	0	0	0	0	0	0	-	0	0	0	0	0	0
Concordia University	0	0	0	0	0	0	0	2	-	0	-	0	-	0
Cooperative Institute for Research														
in Environmental Sciences	0	0	0	0	0	0	0	-	0	0	0	0	0	0
Creighton University	0	0	0	0	0	0	0	0	0	0	0	0	က	-
Dartmouth College	0	2	0	7	-	0	က	7	4	-	-	4	4	က
Davidson College	0	-	0	0	0	0	0	0	0	0	0	0	0	0
Drexel University	0	0	0	0	0	0	0	က	7	2	7	2	9	4
Duquesne University	0	0	0	0	0	0	0	0	0	0	-	0	-	က
Eastern Virginia Medical School	0	0	0	0	0	0	0	0	0	0	0	-	0	0
General Motors Institute	0	0	0	0	-	-	0	4	0	-	-	0	-	0
George Washington University	0	-	0	7	0	0	0	_	0	0	-	7	0	0
Goshen College	0	-	-	0	0	0	0	0	0	0	0	0	0	0
Howard University	0	0	0	0	0	0	0	0	0	0	0	7	0	က
Illinois Institute of Technology	0	0	0	0	0	-	0	0	0	2	-	4	0	7
Lehigh University	-	0	2	0	7	Ω	-	2	4	9	7	4	က	-
Loma Linda University	0	0	0	-	0	0	0	-	7	2	-	7	7	∞
Loyola University of Chicago	0	0	0	0	-	0	0	0	-	-	-	က	-	က
Marquette University	0	0	0	-	0	0	0	0	0	0	0	0	0	2
Mayo Foundation	0	0	0	က	-	-	0	က	4	4	∞	တ	4	9
Medical College of Hampton Roads	0	0	0	-	0	-	-	0	0	0	7	-	-	-
Medical College of Pennsylvania	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Medical College of Wisconsin	0	0	4	က	က	-	10	2	_	_	0	0	က	4
Mercer University	0	0	0	0	0	0	0	0	0	0	0	0	0	-
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Science & Engineering Indicators – 1998

Appendix table 5-57. Universities and colleges with largest 1995 R&D volume and to other academic institutions: 1982-95

Institution	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Milwaukee School of Engineering	0	0	0	0	0	0	0	0	0	1	0	0	0	0
New York Chiropractic College	0	0	0	0	0	0	0	0	-	0	0	0	0	0
New York Institute of Technology	4	0	2	က	7	7	4	က	-	-	2	0	-	0
New York Medical College	0	0	0	0	0	0	-	7	-	-	0	0	7	0
Northeastern University	-	0	0	က	5	7	-	က	4	9	=	10	15	16
Oregon Graduate Center	-	7	က	က	-	7	-	2	-	-	7	0	0	0
Polytechnic University	0	0	0	0	0	7	7	က	က	7	-	-	0	-
Regis College	0	0	0	0	0	0	0	-	0	0	0	0	0	0
Rensselear Polytechnic Institute	4	0	4	2	9	2	7	2	4	7	7	7	7	7
Rice University	0	0	-	0	0	0	0	0	-	0	0	7	7	0
Roanoke College	0	0	-	5	-	-	-	0	-	0	0	0	0	0
Rochester Institute of Technology	0	0	0	0	0	-	0	0	0	0	0	0	-	0
Siena College	0	0	-	0	0	0	0	0	0	0	0	0	0	0
Smith College	0	0	0	0	0	0	-	0	0	0	0	0	0	0
Southern Methodist University	0	0	0	0	-	-	0	0	0	0	0	0	0	0
St. Johns University	0	0	0	-	0	0	0	-	0	0	0	0	0	0
Stevens Institute of Technology	0	0	0	0	0	0	4	0	-	7	0	0	-	-
St. Louis University	0	0	-	0	-	-	-	0	0	7	-	0	0	-
Syracuse University	0	0	-	2	က	7	2	4	တ	7	2	2	က	-
Texas College of Osteopathic Medi	0	0	0	0	0	-	0	0	0	0	0	0	0	0
Texas Wesleyan University	0	0	0	0	0	0	0	0	0	0	-	0	0	0
Thomas Jefferson University	7	4	9	2	က	က	5	7	2	7	80	တ	13	14
Touro College	0	0	0	0	0	0	0	0	-	0	0	0	0	0
Trinity University	0	0	-	0	0	0	0	0	0	0	0	0	7	0
Tuskegee University	0	0	0	0	0	0	0	-	0	0	0	-	0	0
University of Dayton	7	_	7	7	7	2	9	က	2	2	-	က	7	4
University of Denver	0	0	_	0	0	0	0	0	0	0	0	0	0	-
University of Hartford	0	0	0	0	0	0	0	0	0	0	0	-	0	0
University of New England	0	0	0	0	0	0	0	0	0	0	0	0	0	-
University of Notre Dame	0	0	0	_	7	-	7	7	0	က	-	7	က	0
University of Scranton	0	0	0	-	0	0	0	0	0	0	0	0	0	0
University of The Pacific	0	0	0	0	0	0	0	0	-	-	0	0	0	0
Wabash College	0	0	0	-	0	0	0	0	0	0	0	0	0	0
Wake Forest University	0	0	0	0	0	7	က	က	0	-	0	က	4	-
Worcester Polytechnic Institute	-	0	0	0	0	0	0	0	-	0	4	-	2	က
Affiliated organizations ^b	49	52	26	43	51	22	37	34	19	20	17	Ξ	15	6
			 -					:	:	:	:	i		

NOTE: Recording of patents to universities and colleges is not uniform. In some cases, patents may be issued to a systemwide board, rather than to individual institutions within the system. Thus, the institution counts are lower bound numbers.

^aData exclude a small number of unaffiliated organizations holding university patents.

Data include organizations holding academic patents but not affiliated with a single institution, such as the Research Triangle Institute, Research Corporation, etc.

SOURCES: U.S. Patent and Trademark Office, Technology Assessment and Forecast Report, U.S. Universities and Colleges, 1969-95 (Washington, DC: 1996); and National Science Foundation, unpublished tabulations.

See figures 5-31 and 5-32.

Appendix table 5-58. Utility classes emphasized in patents assigned to U.S. universities and colleges: 1969-95 total

		er of U.S. s awarded	University Activity		nulative t of patents
Utility class	Total	Academic	Indexa	Total	Academic
Total, all utility classes	2,052,216	18,701	1.0	100	100
505 Superconductor technology: apparatus, material, process	1,371	148	11.8	0	1
435 Chemistry: molecular biology and microbiology	16,483	1,686	11.2	1	10
530 Chemistry: natural resins or derivatives; peptides, proteins; lignins	4,545	446	10.8	1	12
800 Multicellular living organisms and unmodified parts thereof	255	21	9.0	1	12
536 Organic compounds—part of the class 532-570 series	4,320	307	7.8	1	14
424 Drug, bio-affecting and body treating compositions	15,777	987	6.9	2	19
436 Chemistry: analytical and immunological testing	5,180	306	6.5	2	21
552 Organic compounds—part of the class 532-570 series	2,347	110	5.1	2	21
623 Prosthesis (i.e., artificial body members), aids, accessories	3,988	175	4.8	3	22
527 Synthetic resins or natural rubbers—part of the class 520 series	259	11	4.7	3	22
128 Surgery	14,999	618	4.5	3	26
260 Chemistry of carbon compounds	125	5	4.4	3	26
171 Unearthing plants or buried objects	310	12	4.2	3	26
514 Drug, bio-affecting and body treating compositions	41,293	1,593	4.2	5	34
372 Coherent light generators	6,729	255	4.2	6	36
607 Surgery: light, thermal, and electrical application	3,565	128	3.9	6	36
378 X-ray or gamma ray systems or devices	4,874	168	3.8	6	37
117 Single- and oriented-crystal, epitaxy growth processes; non-coating	2,042	70	3.8	6	38
136 Batteries: thermoelectric and photoelectric	1,933	61	3.5	6	38
127 Sugar, starch, and carbohydrates	875	24	3.0	6	38
204 Chemistry: electrical and wave energy	11,248	286	2.8	7	40
	•	68		7	40
600 Surgery	2,707		2.8	7 7	40 41
556 Organic compounds – part of the class 532-570 series	4,364	109	2.7		
606 Surgery	7,678	183	2.6	8	42
549 Organic compounds—part of the class 532-570 series	7,981	185	2.5	8	43
111 Planting	952	22	2.5	8	43
324 Electricity: measuring and testing	16,573	370	2.5	9	45
250 Radiant energy	21,565	470	2.4	10	47
356 Optics: measuring and testing	12,359	252	2.2	11	49
546 Organic compounds—part of the class 532-570 series	7,325	138	2.1	11	49
604 Surgery	13,703	253	2.0	12	51
419 Powder metallurgy processes	1,635	29	1.9	12	51
87 Textiles: braiding, netting, and lace making	227	4	1.9	12	51
47 Plant husbandry	2,869	49	1.9	12	51
216 Etching a substrate: processes	2,229	38	1.9	12	51
385 Optical waveguides	7,214	120	1.8	12	52
540 Organic compounds—part of the class 532-570 series	6,407	106	1.8	13	52
460 Crop threshing or separating	667	11	1.8	13	53
382 Image analysis	4,139	68	1.8	13	53
257 Active solid-state devices (e.g., transistors, solid-state diodes)	13,852	222	1.8	13	54
359 Optics: systems (including communication) and elements	19,939	316	1.7	14	56
501 Compositions: ceramic	4,732	74	1.7	15	56
73 Measuring and testing	28,848	448	1.7	16	59
554 Organic compounds - part of the class 532-570 series	2,140	33	1.7	16	59
209 Classifying, separating, and assorting solids	5,445	83	1.7	16	59
205 Electrolysis: processes, compositions used, preparation methods	9,543	142	1.6	17	60
426 Food or edible material: processes, compositions, and products	14,440	211	1.6	18	61
95 Gas separation: processes	3,380	49	1.6	18	61
374 Thermal measuring and testing	2,994	43	1.6	18	62
44 Fuel and related compositions	2,736	39	1.6	18	62
427 Coating processes	15,384	219	1.6	19	63
71 Chemistry: fertilizers	1,228	17	1.5	19	63
351 Optics: eye examining, vision testing and correcting	2,789	38	1.5	19	63
437 Semiconductor device manufacturing: process	12,277	165	1.5	20	64
437 Setticolluctor device manufactumia. Diocess					

Appendix table 5-58. Utility classes emphasized in patents assigned to U.S. universities and colleges: 1969-95 total

		per of U.S. s awarded	University Activity		mulative t of patents
Utility class	Total	Academic	Indexa	Total	Academic
588 Hazardous or toxic waste destruction or containment	988	13	1.4	21	66
210 Liquid purification or separation	21,094	277	1.4	22	67
423 Chemistry of inorganic compounds	15,547	204	1.4	23	68
422 Chemical apparatus, process disinfecting, deodorizing, preserving	9,738	126	1.4	23	69
522 Synthetic resins or natural rubbers—part of the class 520 series	1,555	19	1.3	23	69
449 Bee culture	166	2	1.3	23	69
528 Synthetic resins or natural rubbers—part of the class 520 series	13,579	163	1.3	24	70
534 Organic compounds—part of the class 532-570 series	2,701	32	1.3	24	70
343 Communications: radio wave antennas	4,393	52	1.3	24	70
602 Surgery: splint, brace, or bandage	2,408	28	1.3	24	71
333 Wave transmission lines and networks	6,147	70	1.3	25	71
429 Chemistry: electrical current producing apparatus, product, process	7,650	85	1.2	25	71
504 Plant protecting and regulating compositions	6,061	66	1.2	25	72
395 Information processing system organization	20,753	224	1.2	26	73
525 Synthetic resins or natural rubbers—part of the class 520 series	16,325	176	1.2	27	74
363 Electric power conversion systems	4,778	50	1.1	27	74
56 Harvesters	5,414	56	1.1	27	74
119 Animal husbandry	5,337	55	1.1	28	75
568 Organic compounds—part of the class 532-570 series	9,980	102	1.1	28	75
75 Specialized metallurgical processes, compositions for use	6,263	64	1.1	29	76
560 Organic compounds—part of the class 532-570 series	7,774	79	1.1	29	76
96 Gas separation: apparatus	2,169	22	1.1	29	76
148 Metal treatment	7,353	73	1.1	29	77
365 Static information storage and retrieval	9,770	96	1.1	30	77
548 Organic compounds—part of the class 532-570 series	8,572	84	1.1	30	78
601 Surgery: kinesitherapy	2.052	20	1.1	30	78
270 Sheet-material associating	1,233	12	1.1	30	78
502 Catalyst, solid sorbent, or support therefor: product or process	9,454	92	1.1	31	78
562 Organic compounds—part of the class 532-570 series	6,457	62	1.1	31	79
434 Education and demonstration	4,393	42	1.0	31	79
367 Communications, electrical: acoustic wave systems and devices	5,025	48	1.0	32	79
518 Chemistry: Fischer-Tropsch processes; purification or recovery	526	5	1.0	32	79
544 Organic compounds—part of the class 532-570 series	7,883	72	1.0	32	79
558 Organic compounds—part of the class 532-570 series	5,851	53	1.0	32	80
48 Gas: heating and illuminating	1,441	13	1.0	32	80
310 Electrical generator or motor structure	10,661	94	1.0	33	80
380 Cryptography	2,389	21	1.0	33	80
264 Plastic and nonmetallic article shaping or treating: processes	17.694	155	1.0	34	81
521 Synthetic resins or natural rubbers—part of the class 520 series	5,873	51	1.0	34	81
All others	1,350,222	3,462	0.4	66	19

NOTES: This table presents the number and title of selected classes of technology represented in the U.S. Patent Classification system as of December 31, 1995. Patent counts are the total number awarded to all assignees and to U.S. higher education institutions.

SOURCES: U.S. Patent and Trademark Office, Technology Assessment and Forecast Report, U.S. Universities and Colleges, 1969-95 (Washington, DC: 1996); and National Science Foundation, unpublished tabulations.

^aThe University Activity Index is calculated by dividing the proportion of university patents in a given class by the proportion of all patents in that class. Index values greater than 1.0 indicate technology classes that receive relatively greater emphasis in university patenting than elsewhere. Data are presented in declining order of importance.

Appendix table 5-59. Patents awarded to U.S. universities and colleges, by utility class: 1969-74 through 1991-95

			Numbe	er of pat	tents			Percenta	age of p	atents	
Utility	y class	1969- 74	1975- 80	1981- 85	1986- 90	1991- 95	1969- 74	1975- 80	1981- 85	1986- 90	1991- 95
Total	l, all utility classes	1,374	2,064	2,467	4,703	8,093	100	100	100	100	100
435	Chemistry: molecular biology and microbiology	46	99	201	454	886	3	5	8	10	11
514	Drug, bio-affecting and body treating compositions	34	129	232	481	717	2	6	9	10	9
424	Drug, bio-affecting and body treating compositions	40	86	124	256	481	3	4	5	5	6
128	Surgery	34	61	79	158	286	2	3	3	3	4
250	Radiant energy	30	59	46	120	215	2	3	2	3	3
	Chemistry: natural resins or derivatives; peptides or				0		_	•	_	Ū	
	proteins; lignins or reaction products thereof	9	16	83	135	203	1	1	3	3	3
536	Organic compounds—part of the										
	class 532-570 series	13	31	35	63	165	1	2	1	1	2
324	Electricity: measuring and testing	29	18	37	137	149	2	1	1	3	2
364	Electrical computers and data processing systems	11	19	26	88	146	1	1	1	2	2
73	Measuring and testing	59	69	71	104	145	4	3	3	2	2
204	Chemistry: electrical and wave energy	28	24	34	58	142	2	1	1	1	2
359	Optics: systems (including communication)						_	•	•	-	_
	and elements	26	35	31	83	141	2	2	1	2	2
427	Coating processes	7	11	15	55	131	1	1	1	1	2
395	Information processing system organization	18	13	13	51	129	1	1	1	1	2
	Active solid-state devices (e.g., transistors,		10		01	120		•	•	•	_
	solid-state diodes)	7	19	17	53	126	1	1	1	1	2
210	Liquid purification or separation	24	36	32	59	126	2	2	1	1	2
604	Surgery	5	13	36	80	119	0	1	1	2	1
	Superconductor technology:	3	10	00	00	113	U	'	'	_	
505	apparatus, material, process	0	0	0	29	119	0	0	0	1	1
372	Coherent light generators	13	19	29	77	117	1	1	1	2	1
436	Chemistry: analytical and immunological testing	13	61	67	61	104	1	3	3	1	1
428	Stock material or miscellaneous articles	12	16	32	50	96	1	1	1	1	1
356	Optics: measuring and testing	17	25	31	86	93	1	1	1	2	1
	Synthetic resins or natural rubbers—	17	23	31	00	93	'	'	'	2	1
323	part of the class 520 series	4	20	24	37	91	0	1	1	1	1
E00	Synthetic resins or natural rubbers—	4	20	24	31	91	U	'	'	'	1
320	part of the class 520 series	13	22	6	32	90	1	1	0	1	1
127	Semiconductor device manufacturing: process	3	13	26	43	80	0	1	1	1	1
423	Chemistry of inorganic compounds	26	41	27	30	80	2	2	1	1	1
606	Surgery	13	11	22	58	79	1	1	1	1	1
	Plastic and nonmetallic article shaping	10		22	50	13	'	'	'	'	'
204		7	20	20	33	75	1	1	1	1	1
126	or treating: processes	,	20	20	33	73	'	'	'	'	1
420	compositions, and products	24	39	39	35	74	2	2	2	1	1
540	·	24	39	39	33	74	2	2	2	1	'
549	Organic compounds— part of the class 532-570 series	4	32	37	40	72	0	2	1	1	1
5/6	Organic compounds—	4	32	31	40	12	U	2	'	1	'
340	part of the class 532-570 series	9	28	9	29	63	1	1	0	1	1
270	X-ray or gamma ray systems or devices	16	30	23	36	63	1	1	1	1	1 1
	, , ,	10	30	23	30	03	'	'	'	1	ı
023	Prosthesis (i.e., artificial body members),	20	15	01	ΕO	60	4	4	4	4	4
252	parts thereof, or aids and accessories therefor	20 9	15 15	21 18	59 24	60 59	1 1	1 1	1	1 1	1 1
	Compositions	9	15	10	24	59	'	'	'	'	'
422		7	11	10	24	E0	1	4	4	1	4
205	deodorizing, preserving, or sterilizing Electrolysis: processes, compositions used therein,	7	14	13	34	58	I	1	1	ı	1
200	and methods of preparing the compositions	6	17	29	35	55	0	4	4	4	4
348		11	10	29 4	32	53	1	1 0	1 0	1 1	1 1
		11	10	4	32	55	'	U	U	'	1
550	Organic compounds—	0	0	10	26	EO	4	0	1	1	4
EOO	part of the class 532-570 series	9	8	13	26	53	1	0	ı	ı	1
502	Catalyst, solid sorbent, or support therefor:	4	9	44	22	40	0	0	0	0	4
205	product or process of making	1 1	9	11 19	48	49 43	0	0	1		1
	Optical waveguides					43				1	1
007	Surgery: light, thermal, and electrical application	5	17	20	44	42	0	1	1	1	1

Appendix table 5-59. Patents awarded to U.S. universities and colleges, by utility class: 1969-74 through 1991-95

		Numb	er of pa	atents			Percent	age of p	atents	
Utility class	1969- 74	1975- 80	1981- 85	1986- 90	1991- 95	1969- 74	1975- 80	1981- 85	1986- 90	1991- 95
501 Compositions: ceramic	0	5	6	22	41	0	0	0	0	1
part of the class 520 series	1	8	3	19	39	0	0	0	0	0
382 Image analysis	1	2	5	22	38	0	0	0	0	0
part of the class 532-570 series	5	16	12	36	37	0	1	0	1	0
148 Metal treatment	2	10	12	14	35	0	0	0	0	0
318 Electricity: motive power systems	7	7	5	7	33	1	0	0	0	0
part of the class 532-570 series	2	7	10	20	33	0	0	0	0	0
219 Electric heating	4	10	9	15	32	0	0	0	0	0
365 Static information storage and retrieval548 Organic compounds—	23	9	7	25	32	2	0	0	1	0
part of the class 532-570 series	3	15	9	25	32	0	1	0	1	0
part of the class 532-570 series	13	29	14	15	31	1	1	1	0	0
504 Plant protecting and regulating compositions	3	8	4	20	31	0	0	0	0	0
All other utility classes	647	709	719	1,028	1,604	47	34	29	22	20

SOURCES: U.S. Patent and Trademark Office, Technology Assessment and Forecast Report, U.S. Universities and Colleges, 1969-95 (Washington, DC: 1996); and National Science Foundation, unpublished tabulations.

See figure 5-33.

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Appendix table 6-1.

Real gross domestic product, for selected countries: 1960-95
(Billions of 1995 U.S. dollars)

	United	Canada	Japan	South Korea	Austria	Belgium	Denmark	France	Germany ^a	Italy	Nether- lands	Norway	Sweden	United Kingdom
	2,433.07 2,484.81	170.88 176.24 188.73	415.98 476.54 510.18	36.12 38.23 39.05	55.01 57.93 59.32	76.32 80.11 84.29	43.97 46.56 49.12	378.74 399.60 426.26	544.64 569.86 596.43	345.35 373.69 396.87	100.42 103.33 107.77	29.26 31.04 31.88	70.36 74.36 77.53	507.23 520.29 527.20
	2,747.51	198.52	563.76	42.62	61.74	87.96	49.35	449.05	613.21	419.14	111.33	33.08	81.66	548.05
964 965	2,907.69 3,092.62	211.76 225.73	638.25 671.01	46.74 49.42	65.47 67.34	94.08 97.43	53.76 56.34	478.32 501.18	654.06 689.08	430.86 444.94	120.90 127.31	34.74 36.58	87.23 90.56	577.85 592.48
996	3,292.07	241.05	742.11	55.44	71.14	100.51	57.67	527.31	708.30	471.57	130.87	37.96	92.46	603.68
967	3,378.13	248.12	822.07	58.71	73.28	104.40	59.64	552.03	706.12	505.42	137.81	40.34	95.57	617.52
969	3,537.77 3,644.70	261.40 275.40	927.04 1,040.77	65.36 74.42	76.56 81.36	108.79 116.01	62.01 65.93	575.54 615.77	744.63 800.18	538.50 571.34	147.04 157.04	41.25 43.11	99.05 104.01	642.68 655.93
970	3,644.92	282.55	1,142.86	80.94	87.16	123.39	67.26	651.06	840.49	601.68	166.07	43.97	110.74	670.90
971	3,765.30	298.82	1,193.03	87.81	91.61	127.92	90.69	682.20	866.19	613.08	173.46	45.98	111.79	684.23
972	3,969.91	315.94	1,293.40	92.04	97.30	134.68	72.70	712.43	903.01	631.02	178.85	48.36 50.34	114.34	708.19
974	4,182.80	355.29	1,380.17	112.20	106.08	148.47	74.64	774.55	947.89	703.83	195.49	52.96	122.68	747.39
975	4,157.95	364.53	1,422.84	119.64	105.70	146.26	74.15	772.39	936.02	688.72	195.78	55.17	125.82	742.01
926	4,390.32	386.99	1,479.40	133.72	110.53	154.41	78.95	805.17	985.85	733.47	205.11	58.92	127.15	762.61
977	4,603.54	400.98	1,544.35	147.51	115.55	155.15	80.23	831.07	1,013.90	754.67	209.90	61.03	125.12	780.63
9/8	4,834.18	419.32	1,625.77	161.36	115.62	159.39	81.41	858.92	1,044.29	/82.80	214.85	63.80	127.31	807.61
	00.4.0.	00.00	1,714.33	10.211	01.12	67.201	04.30	07.000	1,000.41	12.120	219.03	40.70	02.20	930.20
980	4,961.34	442.02	1,763.25	168.23	124.64	169.82	83.92	901.16	1,099.08	856.42	222.28	69.86	134.40	812.25
1982	5,082.90	458.25 443.51	1,819.15	1,8.67	124.28	169.83	83.18	911.76	1,100.17	860.48	221.16	70.47	135.73	801.77
983	5,174.45	457.54	1,918.30	214.33	128.11	170.08	87.85	941.47	1,108.99	874.95	222.32	73.98	138.11	845.62
984	5,527.51	486.40	1,993.44	232.93	129.85	173.81	91.70	953.84	1,140.20	897.42	229.63	78.23	143.70	865.27
985	5,733.31	509.59	2,081.24	248.18	133.05	175.10	95.64	971.79	1,163.35	922.64	236.70	82.36	146.47	897.76
986	5,905.86	526.49	2,141.50	276.86	134.62	177.96	99.12	996.26	1,190.63	948.84	243.22	85.80	149.83	936.21
907	6,076.37	575 73	2,230.30	3/3 55	120.03	101.74	99.4 I	1,010.00	1,200.23	970.22	240.00	10.70	158.03	901.27
989	6,519.59	589.81	2,483.18	365.48	147.86	197.26	101.14	1,109.77	1,298.64	1,045.35	264.96	87.86	161.78	1,052.86
066	6,603.82	588.43	2,609.42	400.23	154.14	204.52	102.58	1,137.60	1,372.71	1,067.96	275.84	89.50	163.99	1,057.04
	6,539.60	577.91	2,713.01	436.78	158.52	207.74	103.96	1,146.48	1,441.98	1,080.12	282.11	92.29	162.16	1,036.31
1992		582.33	2,741.60	458.91	161.75	211.25	104.20	1,159.81	1,467.42	1,086.22	287.82	95.31	159.85	1,030.82
1993		595.26	2,745.11	485.30	162.34	208.39	105.74	1,144.38	1,438.83	1,073.67	290.02	97.95	156.30	1,052.18
1994 1995	7,109.43 7,253.80	619.49 633.90	2,758.25 2,781.74	526.93 574.11	167.29 170.34	213.27 217.39	110.38 113.45	1,176.72 1,202.09	1,470.80 1,494.22	1,096.49 1,129.04	299.85 306.27	102.88 106.24	161.52 167.29	1,092.55 1,119.85

NOTE: Country gross domestic products were determined with 1993 purchasing power parities using the Elteto-Köves-Szulc (EKS) aggregation method, which is the method used by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT in their official statistics. For a discussion of the properties of this aggregation method, see OECD, Purchasing Power Parities and Real Expenditures, 1993: Volume 1, EKS Results (Paris: 1995), p. 4.

SOURCE: U.S. Bureau of Labor Statistics, Office of Productivity and Technology, "Comparative Real Gross Domestic Product Per Capita and Per Employed Person, Fourteen Countries, 1960-1995" (Washington, DC: April 1997).

See figure 6-1.

rman data are for the former West Germany on

Appendix table 6-2. **Real gross domestic product per capita, for selected countries: 1960-95** (1995 U.S. dollars)

	United	Canada	Japan	South	Austria	Belgium	Denmark	France	Germany ^a	Italy	Nether- lands	Norway	Sweden	United Kingdom
1960 1961	13,460 13,523 14,120	9,542 9,646 10,139	4,460 5,065 5,371	1,444 1,484 1,473	7,806 8,175 8,320	8,338 8,723 9,141	9,598 10,094 10,571	8,290 8,656 9,070	9,825 10,144 10,494	7,053 7,602 8,007	8,745 8,879 9,132	8,170 8,599 8,760	9,406 9,889 10,253	9,685 9,853 9,893
1963 1964 1965	14,514 15,150	10,468 10,958	5,879 6,587	1,563 1,670 1,733	8,604 9,063	9,468 10,032	10,536	9,387	10,685 11,282	8,394 8,542 753	9,305 9,971	9,023 9,404	10,739	10,220
1965 1966 1967	16,745 16,745	12,024	7,507	1,722 1,883 1948	9,716 9,716 9,34	10,534	12,021 12,325	10,275 10,721 11,137	11,975	9,732 9,206 783	10,508	9,824 10,113 10,654	11,842	11,048
1968 1969	17,623 17,978	12,610 13,097	9,172 10,172	2,120	10,324 10,934	11,310 12,027	12,741 13,474	11,530 12,238	12,515 13,322	10,347 10,908	11,555 12,199	10,801 11,194	12,515 13,050	11,640
1970 1971	17,772 18,129	13,250 13,566	11,019 11,389	2,510 2,670	11,672 12,214	12,786 13,225	13,647 13,915	12,823 13,311	13,858 14,134	11,402 11,541	12,743 13,147	11,339	13,769 13,804	12,060 12,234
1972 1973	18,911 19,807	14,178 15,085	12,181 12,859	2,747 3,044	12,897 13,453	13,871 14,646	14,564 15,002	13,780 14,413	14,642 15,265	11,795 12,477	13,417 13,981	12,295 12,711	14,078 14,610	12,624 13,523
1974	19,555 19,251	15,532 15,706	12,529 12,759	3,234 3,391	13,960 13,946	15,200 14,932	14,795 14,653	14,764 14,657	15,275 15,139	12,940 12,576	14,434 14,333	13,289	15,034 15,357	13,290 13,197
1976	20,131 20,898	16,456 16,850	13,119 13,561	3,730 4,051	14,610 15,268	15,739 15,796	15,562 15,768	15,218 15,638	16,022 16,513	13,319 13,655	14,892 15,149	14,635 15,095	15,464 15,163	13,566 13,893
19781979	21,714 22,098	17,445 17,941	14,147 14,799	4,365 4,606	15,289 16,041	16,215 16,549	15,951 16,474	16,092 16,542	17,028 17,738	14,118 14,877	15,414 15,650	15,721 16,461	15,383 15,939	14,376 14,762
19801981	21,786 22,099	17,973 18,404	15,096 15,462	4,413 4,614	16,509	17,245	16,382	16,725 16,828	17,852 17,836	15,387	15,711	17,098	16,173	14,419
1983 1983	22,082 23,383	17,974 18,925	16,085	4,000 5,370 7,765	16,930	17,258	17,178	17,189	18,055 18,655	15,561	15,473	17,920	16,582	14,999
1985 1986	24,038 24,538	19,644	17,236 17,627	6,082 6,718	17,557	17,762 18,045	18,701 19,356	17,578	19,064 19,497	16,330	16,338	19,833	17,541	15,838 16,468
1987 1988	25,022 25,737	20,656 21,407	18,270 19,319	7,418	18,012 18,700	18,413	19,390 19,604	18,248 18,969	19,782 20,394	17,264	16,821 17,148	20,900	18,403	17,213
1989	26,354	21,542	20,169	8,610	19,306	19,849	19,705	19,669	20,924	18,392	17,847	20,785	19,049	18,356
1990 1991	26,420 25,881	21,174 20,551	21,122 21,893	၈ ၀	19,943 20,289	20,520 20,764	19,954 20,169	20,051 20,094	21,702 22,505	18,757 18,912	18,455 18,722	21,101 21,655	19,160 18,817	18,364 17,927
1992	26,299 26,613	20,403 20,564	22,053 22,019	10,490 10,981	20,440 20,315	21,030 20,666	20,148 20,380	20,215 19,849	22,623 21,956	18,994 19,035	18,958 18,968	22,235 22,716	18,441 17,927	17,771 18,082
1995	27,273 27,572	21,175 21,405	22,073 22,210	11,804 12,732	20,834 21,170	21,083 21,445	21,201 21,678	20,323 20,675	22,333 22,586	19,393 19,934	19,495 19,814	23,724 24,371	18,394 18,952	18,710 19,108

NOTE: Country gross domestic products were determined with 1993 purchasing power parities using the Elteto-Köves-Szulo (EKS) aggregation method, which is the method used by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT in their official statistics. For a discussion of the properties of this aggregation method, see OECD, Purchasing Power Parities and Real Expenditures, 1993: Volume 1, EKS Results (Paris: 1995), p. 4.

SOURCE: U.S. Bureau of Labor Statistics, Office of Productivity and Technology, "Comparative Real Gross Domestic Product Per Capita and Per Employed Person, Fourteen Countries, 1960-1995" (Washington, DC: April 1997).

See figure 6-1.

^aGerman data are for the former West Germany only.

Appendix table 6-3. **Real gross domestic product per employed person, for selected countries: 1960-95** (1995 U.S. dollars)

United Kingdom	21,030 21,350 21,527 22,324 23,235 23,586 23,975 24,810 25,946 26,481	27,162 28,111 28,917 30,449 29,860 29,799 30,875 31,566 32,395 32,395	32,503 33,227 34,155 35,575 36,688 38,027 38,970 39,554 39,508 39,508 39,508 41,085 42,298 43,137
Sweden	19,461 20,401 21,155 22,171 23,348 24,074 24,543 25,643 26,297 27,104	28,305 28,628 29,187 30,232 30,592 30,766 30,985 30,489 30,489 30,486 31,571	31,746 31,690 32,069 32,556 33,594 34,457 35,260 35,260 35,865 35,867 36,043 36,043 36,043 36,043 36,043 37,330 38,516 40,209
Norway	19,090 19,940 20,362 22,023 22,023 22,996 23,761 25,074 25,074 25,608	26,631 27,597 28,712 29,696 30,836 31,512 32,572 32,896 33,784 34,956	35,621 35,687 37,437 39,346 40,339 40,752 40,853 42,420 43,569 45,572 46,888 48,093 49,930 50,511
Nether- lands	21,801 22,111 22,609 23,041 24,590 25,675 26,190 27,664 29,246 30,723	32,109 33,339 34,675 36,410 37,521 37,869 39,445 39,529 40,084	39,482 39,073 38,824 41,079 41,165 41,525 42,540 43,578 43,578 43,578 43,578 43,578 43,578 44,554 44,554 44,554
Italy	<u> </u>	2222222222	NA 41,076 41,401 42,732 44,835 46,373 48,472 49,472 49,955 50,176 50,887 51,592 53,587
Germany ^a	20,897 21,564 22,492 23,069 24,585 25,755 26,555 27,365 28,833 30,509	31,645 32,481 33,727 34,953 35,451 35,973 38,090 39,118 39,965 40,967	40,737 40,821 40,925 43,365 43,365 44,366 45,971 46,953 48,201 49,402 49,603 51,310 52,462
France	19,190 20,249 21,605 22,579 23,789 24,849 25,951 27,098 28,337 29,862	31,151 32,494 33,735 35,084 35,863 36,077 37,315 38,198 39,284 40,481	41,070 41,755 42,701 44,071 44,973 46,807 46,807 46,807 49,885 50,611 50,951 51,921 51,932 53,335 53,335
Denmark	21,664 22,607 23,493 23,315 24,887 25,613 25,776 26,826 26,826 27,582	29,445 30,057 30,993 31,718 31,527 31,720 33,443 33,584 34,360	34,369 34,517 35,400 36,184 37,778 37,778 37,938 37,938 39,044 40,002 41,154 41,510 44,664 45,166
Belgium	21,993 22,916 23,744 24,604 25,945 26,766 27,514 28,706 29,945 31,398	33,368 34,351 36,243 38,057 39,003 41,409 41,774 42,871	45,308 45,422 46,785 47,337 48,557 49,011 49,805 51,609 52,463 53,624 54,396 55,409 57,106 57,106
Austria	17,219 17,990 18,571 19,458 20,663 21,393 22,826 23,931 25,329 26,936	28,743 29,864 31,495 32,477 33,474 33,551 34,881 36,136 36,074	38,535 38,406 39,318 40,479 41,049 42,272 42,991 44,473 45,499 46,530 47,103 47,103 47,103 47,46 48,289 49,693 50,746
South Korea	NA NA NA S,562 5,993 6,022 6,582 6,735 7,140 7,905	8,305 8,727 8,717 9,320 9,684 10,114 10,650 11,962 12,652	12,295 12,741 13,369 14,776 16,578 17,856 17,856 18,879 20,366 20,366 22,131 23,468 24,203 25,206 26,563 28,174
Japan	9,545 10,791 11,421 12,514 13,960 14,452 15,646 16,981 18,793	22,685 23,526 25,451 26,799 26,567 27,484 28,308 29,161 30,326 31,594	32,153 32,896 33,562 33,779 34,905 36,195 36,935 36,935 36,030 39,777 40,882 42,121 42,955 42,931 42,959 43,030
Canada	\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	NA NA NA NA NA NA 39,289 39,891 40,339 40,199	39,625 39,945 39,920 40,918 42,381 42,254 43,254 43,870 44,801 44,433 44,475 45,079 46,345 46,345
United States	35,627 36,371 37,893 38,972 40,361 41,900 43,307 43,411 44,526 44,771	44,523 45,816 46,925 48,037 46,986 47,236 48,300 48,896 49,245	48,926 49,570 48,905 50,221 51,551 52,415 52,806 52,806 54,534 54,534 54,534 54,595 54,571 56,279 56,978
	1960 1961 1962 1963 1965 1966 1967 1988	1970 1971 1972 1973 1976 1976 1977	1980 1981 1982 1983 1984 1986 1987 1989 1990 1991 1993 1994

NA = not available

NOTE: Country gross domestic products were determined with 1993 purchasing power parities using the Elteto-Köves-Szulc (EKS) aggregation method, which is the method used by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT in their official statistics. For a discussion of the properties of this aggregation method, see OECD, Purchasing Power Parities and Real Expenditures, 1993: Volume 1, EKS Results (Paris: 1995), p. 4.

^aGerman data are for the former West Germany only.

SOURCE: U.S. Bureau of Labor Statistics, Office of Productivity and Technology, "Comparative Real Gross Domestic Product Per Capita and Per Employed Person, Fourteen Countries, 1960-1995" (Washington, DC: April 1997).

See figure 6-1.

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Aircraft	raft	Communications	cations	Office & computers	mputers	Drugs & medicines	edicines	High-tech manufacturing	ınufacturing	Other manufacturing	facturing
	Value added (millions of nat'l currency)	Value added/ production (percent)a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						United	United States							
1970	249,584.0	39.9	A A	Ν	6,664.1	46.3	3,233.6	44.0	3,425.6	5 51.6	N	A	NA	Ϋ́
1971	263,018.0	40.0	10,495.9	¥	6,992.5	47.8	3,072.0	48.3	3,795.8	3 53.3	24,356.2	86.7	AN	Ϋ́
1972	290,424.0	38.9	11,234.4	47.9	7,528.8	45.6	3,620.5	45.5	4,465.2	56.9	26,848.9	48.1	263,575.1	38.2
1973	323,403.0	37.4	12,165.5	42.1	8,796.2	44.3	4,022.8	44.5	4,736.4	1 54.2	29,721.0	44.7	293,682.0	36.8
1974	337,278.0	33.3	12,819.4	42.6	7,062.3	35.2	4,451.3	45.6	4,668.2	2 46.8	29,001.3	41.5	308,276.8	32.7
1975	354,689.0	34.8	13,172.8	41.3	8,791.1	43.7	4,827.9	52.9	5,408.9	9 49.5	32,200.7	45.0	322,488.3	34.1
1976	405,313.0	34.7	14,018.4	44.0	9,900.5	42.9	5,536.7	43.3	6,408.5		35,864.0	44.6	369,449.0	34.0
1977	462,365.0	34.5	15,814.7	47.0	12,683.5	43.4	6,661.2	40.4	6,728.6	3 47.7	41,888.0	44.8	420,477.0	33.8
1978	516,936.0	34.4	18,499.0	45.1	14,580.6	42.6	8,246.0	40.9	7,427.8	3 46.2	48,753.4	43.7	468,182.6	33.6
1979	571,281.0	33.5	20,217.6	37.7	15,332.4	38.4	9,853.0	38.3	8,099.3	3 48.1	53,502.2	39.3	517,778.8	33.0
1980	584,406.0	32.1	20,083.8	32.8	19,821.6	41.8	11,959.5	38.4	9,352.2	2 48.1	61,217.1	38.4	523,188.9	31.5
1981	652,014.0	32.7	30,723.8	46.1	23,437.1	44.2	13,745.7	39.1	10,958.3	3 50.3	78,864.9	44.6	573,149.1	31.6
1982	649,768.0	33.7	33,401.5	46.8	24,414.1	43.2	15,330.3	37.4	12,911.4	1 53.2	86,057.3	44.6	563,710.7	32.5
1983	690,088.0	33.8	37,898.5	49.4	29,013.1	45.0	17,314.5	37.7	14,703.9	9 54.2	98,930.0	46.1	591,158.0	32.3
1984	780,524.0	34.3	39,989.5	46.1	36,191.5	43.3	19,856.0	35.1	15,304.0	53.2	111,341.0	43.6	669,183.0	33.2
1985	802,938.0	35.0	43,277.1	45.2	40,016.8	44.5	20,101.8	35.4	17,315.7	7 55.7	120,711.4	44.1	682,226.6	33.8
1986	833,149.0	36.4	48,064.1	46.4	41,814.8	44.2	18,079.4		18,691.8		126,650.1	44.5	706,498.9	35.3
1987	889,047.0	36.4	47,786.5	43.4	48,234.5	51.9	17,187.1	32.5	20,683.6	54.3	133,891.7	45.6	755,155.3	35.1
1988	971,297.0	36.5	49,504.9	43.5	51,642.7	51.6	18,864.1	31.4	23,209.5	5 54.1	143,221.2	45.2	828,075.8	35.3
1989	1,013,420.0	36.0	51,646.4	43.6	56,792.5	54.1	19,512.1	32.5	25,769.1	1 53.1	153,720.1	46.3	859,699.9	34.6
1990	1,031,350.0	35.8	53,608.2	41.0	57,367.3	52.6	19,299.1	33.2	29,075.2	2 55.0	159,349.8	45.4	872,000.2	34.5
1991	1,028,060.0	36.2	47,616.7	36.3	60,357.8	53.1	16,819.8	31.3	33,416.9	9 55.5	158,211.2	44.1	869,848.8	35.1
1992	1,063,570.0	35.9	45,246.7	35.4	62,524.0	49.2	17,618.3	29.6	36,165.7	7 55.2	161,554.7	42.5	902,015.3	34.9
1993	1,116,530.0	36.1	39,487.0	32.6	70,890.2	51.1	17,458.4	27.9	38,624.2	56.4	166,459.8	45.6	950,070.2	35.1
1994	1,197,090.0	36.2	¥ V	N A	84,507.9	53.9	19,521.9	27.3	40,586.0) 55.0	N	¥	AN	¥
1995	1,287,710.0	36.2	Y V	¥	Z	ΑN	Y Y	NA	AN	NA V	Ϋ́	¥	AN	¥

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Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	ıfacturing	Airc	Aircraft	Communications	cations	Office & computers	mputers	Drugs & medicines	edicines	High-tech manufacturing	nufacturing	Other manufacturing	facturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						 ქმţ	Japan							
1970	26,402,200.0	32.8	44,334.4	44.3	1,470,640.0	37.5	312,745.0	36.2	549,674.0	55.8	2,377,393.4	40.5	24,024,806.6	32.2
1971	28,430,200.0	33.8	51,899.5	45.3	1,458,200.0	37.7	327,933.0	38.1	658,130.0	0.09 (2,496,162.5	45.0	25,934,037.5	33.1
1972	31,917,900.0	34.3	62,418.6	45.3	1,738,620.0	39.1	365,772.0	39.5	672,480.0	61.4	2,839,290.6	43.0	29,078,609.4	33.7
1973	39,568,100.0	33.5	90,705.1	47.1	1,972,330.0	37.5	449,269.0	35.6	704,728.0	28.7	3,217,032.1	40.6	36,351,067.9	32.9
1974	45,137,200.0	30.8	108,524.0	48.5	2,078,780.0	37.0	581,084.0	36.1	619,336.0	42.4	3,387,724.0	38.0	41,749,476.0	30.3
1975	44,800,800.0	31.0	121,152.0	49.0	1,972,680.0	38.4	556,282.0	36.9	856,016.0	51.6	3,506,130.0	41.0	41,294,670.0	30.4
1976	51,100,500.0	30.9	133,580.0	49.5	2,618,840.0	36.0	600,145.0		995,602.0		4,348,167.0	39.9	46,752,333.0	30.2
1977	55,412,200.0	31.2	132,919.0	49.0	2,822,760.0	36.4	726,608.0	33.5	1,178,250.0		4,860,537.0	39.7	50,551,663.0	30.6
1978	60,545,300.0	32.6	148,533.0	49.0	2,928,110.0	36.2	836,794.0	33.5	1,502,180.0		5,415,617.0	41.3	55,129,683.0	32.0
1979	64,815,400.0	31.2	134,096.0	42.8	3,240,990.0	35.4	989,708.0	33.7	1,312,850.0) 55.6	5,677,644.0	38.4	59,137,756.0	30.7
1980	70,232,300.0	29.0	153,506.0	44.4	3,932,900.0	33.2	1,179,570.0	33.5	1,476,360.0	52.4	6,742,336.0	36.4	63,489,964.0	28.3
1981	74,938,500.0	29.9	147,224.0	44.6	4,865,830.0	33.3	1,335,990.0	32.4	1,760,620.0) 55.5	8,109,664.0	36.5	66,828,836.0	29.2
1982	78,467,500.0	30.9	176,235.0	42.7	5,393,120.0	35.3	1,542,630.0	34.0	1,928,100.0		9,040,085.0	38.2	69,427,415.0	30.1
1983	81,747,700.0	31.5	203,000.0	43.8	6,278,730.0	34.8	1,986,090.0	34.3	2,093,640.0		10,561,460.0	37.9	71,186,240.0	30.7
1984	89,244,900.0	31.9	231,453.0	45.0	8,146,470.0	34.7	2,342,440.0	32.7	2,046,000.0		12,766,363.0	36.7	76,478,537.0	31.2
1985	94,672,600.0	32.9	283,397.0	45.1	8,276,160.0	35.3	2,853,440.0	35.6	2,107,600.0		13,520,597.0	37.8	81,152,003.0	32.2
1986	95,817,400.0	32.0	265,439.0	44.0	8,308,320.0	35.3	2,912,310.0	36.6	2,326,180.0		13,812,249.0	38.5	82,005,151.0	34.4
1987	98,406,700.0	36.2	331,277.0	47.6	8,285,500.0	35.6	2,895,760.0		2,478,640.0	(1.7	13,991,177.0	38.5	84,415,523.0	35.8
1988	105,000,000.0	35.9	297,266.0	41.4	9,291,270.0	35.2	3,117,800.0		2,526,560.0		15,232,896.0	37.8	89,767,104.0	35.6
1989	113,000,000.0	35.7	265,123.0	36.2	10,281,900.0	36.0	3,535,620.0	34.9	2,756,460.0	0 61.2	16,839,103.0	38.4	96,160,897.0	35.3
1990	121,000,000.0	35.6	262,173.0	35.1	10,973,200.0	36.3	3,946,330.0	35.0	2,778,640.0	60.3	17,960,343.0	38.3	103,039,657.0	35.2
1991	129,000,000.0	36.1	276,712.0	37.0	11,580,100.0	35.7	4,218,600.0	34.4	2,864,740.0	2.09 (18,940,152.0	37.8	110,059,848.0	35.8
1992	128,000,000.0	37.1	316,265.0	38.9	10,349,400.0	35.5	4,007,420.0	33.7	2,992,610.0	61.4	17,665,695.0	37.8	110,334,305.0	37.0
1993	121,000,000.0	37.1	350,262.0	41.7	9,763,680.0	34.8	3,430,760.0	31.7	3,098,270.0	61.8	16,642,972.0	37.2	104,357,028.0	37.1
1994	117,000,000.0	37.2	A A	Ϋ́	9,629,530.0	35.5	3,189,820.0	34.2	3,115,700.0	NA	A A	¥	NA	¥
1995	120,000,000.0	37.2	Ν	Ϋ́	¥ Z	Ϋ́	A A	Ϋ́	NA	NA NA	NA	Ν	Ϋ́	Ϋ́
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Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Airc	Aircraft	Communications	cations	Office & computers	mputers	Drugs & medicines	adicines	High-tech manufacturing	anufacturing	Other manufacturing	ıfacturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added, production (percent) ^a
						Gerr	Germany							
1970	259,450.0	40.0	934.6	33.7	N A	NA	4,018.1	79.7	AN	NA	ΑΝ	¥	N	A A
1971	277,210.0	40.2	1,011.1	33.5	AN	¥	4,383.3	80.0	NA	AN V	∀ Z	¥	NA	Ϋ́
1972	295,650.0	40.4	1,159.2	37.5	NA	¥	5,033.5	9.08	NA	AN.	Ϋ́	¥	AN	Ϋ́
1973	332,580.0	40.2	1,651.3	42.9	NA N	¥	5,238.3	81.0	NA	NA N	Ϋ́	Ϋ́	NA	
1974	354,320.0	38.0	1,647.1	38.9	AN	¥	5,311.6	9.62	NA	AN V	∀ Z	¥	NA	Ϋ́
1975	352,540.0	38.0	1,528.7	39.8	NA	¥	4,551.5	82.5	5,501.4	1 48.7	Ϋ́	¥	NA	Ϋ́
1976	387,270.0	37.4	1,744.7	45.8	21,028.0	20.0	4,934.4	83.1	6,050.4	47.9	33,757.5	52.4	353,512.5	36.4
1977	411,480.0	38.2	1,764.5	46.4	22,689.3	56.3	5,930.0	81.8	6,444.5	46.7	36,828.3	56.5	374,651.7	37.0
1978	435,350.0	38.9	2,491.1	55.0	22,894.1	56.4	5,951.5	81.6	6,993.3	50.4	38,330.1	27.8	397,019.9	37.7
1979	467,080.0	37.7	2,928.2	48.9	23,919.8	54.5	6,130.5	81.4	7,466.1	9.09	40,444.6	26.0	426,635.4	36.5
1980	476,250.0	35.8	3,272.1	38.1	25,281.6	54.0	6,236.4	77.8	7,356.0	1.74	42,146.1	53.3	434,103.9	34.7
1981	485,710.0	35.0	3,894.3	39.7	26,710.0	54.2	7,582.4		8,257.4	1 49.3	46,444.0	54.1	439,266.0	33.8
1982	496,010.0		3,938.0	34.2	29,017.4	54.6	8,595.1	81.5	8,579.9	50.5	50,130.4	54.4	445,879.6	33.9
1983	519,420.0	35.9	3,932.2	39.0	30,586.4	53.3	9,645.1	76.4	9,676.3	3 51.5	53,840.0	54.5	465,580.0	34.5
1984	542,600.0	35.2	4,261.0	42.4	31,774.7	52.2	10,732.0	63.7	9,902.6	3 49.2	56,670.3	52.5	485,929.7	33.9
1985	578,850.0	35.3	4,390.4	40.9	35,119.6	50.4	11,645.3	29.0	10,367.3	3 49.9	61,522.6	6.05	517,327.4	34.1
1986	620,440.0	38.0	4,716.0	44.5	37,748.9	49.7	12,199.6	62.4	11,770.7		66,435.2	51.8	554,004.8	36.8
1987	624,690.0	38.1	5,005.4	41.4	40,639.2	55.8	11,786.0		11,267.4		68,698.0	54.5	555,992.0	36.8
1988	652,670.0	37.7	5,534.7	45.9	43,421.3	57.2	12,208.3	63.3	12,339.5		73,503.8	55.8	579,166.2	36.2
1989	686,010.0	36.6	6,254.1	37.7	46,078.2	56.5	11,959.0	63.6	12,793.0	0.84	77,084.3	53.7	608,925.7	35.2
1990	741,550.0	37.0	6,751.8	36.3	48,472.8	54.1	12,635.2	61.0	13,462.0	1.74	81,321.8	51.6	660,228.2	35.7
1991	790,660.0	36.8	7,648.6	38.7	48,115.2	48.6	16,935.1	58.9	14,714.5	49.9	87,413.4	49.4	703,246.6	35.6
1992	799,090.0	37.1	7,585.2	42.7	48,153.7	48.0	14,677.4	55.4	15,746.1	49.7	86,162.4	48.9	712,927.6	36.0
1993	746,310.0	37.2	N	Y Y	45,918.9	46.4	11,288.3	52.4	16,032.3	51.3	¥ V	¥	A A	Ϋ́
1994	765,980.0	36.9	N	A A	46,476.6	45.8	12,332.2	49.4	16,747.5	51.0	NA	Ϋ́	Ā	¥
1995	789,452.0	36.9	Ϋ́	ΑN	N A	NA	AN	A N	NA	NA	NA	Ϋ́	N	

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Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Aircraft	raft	Communications	ications	Office & computers	mputers	Drugs & medicines	dicines	High-tech manufacturing	nufacturing	Other manufacturing	acturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added V (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						Fra	France							
1970	215,840.0		3,042.1	35.8	6,646.6	52.6	4,787.8	61.4	2,449.5	30.8	16,925.9	45.9	198,914.1	38.0
1971	238,979.0	38.7	3,373.1	36.0	7,610.5	52.3	4,958.0	6.69	2,828.0	30.9	18,769.6	45.4	220,209.4	38.3
1972	265,734.0	38.8	3,861.5	36.8	8,710.6	20.7	5,288.2	59.3	2,995.6	30.6	20,855.9	45.0	244,878.1	38.4
1973	302,922.0		4,261.5	35.6	10,425.4	20.0	4,959.0		3,491.6		23,137.5	43.7	279,784.5	37.8
1974	342,318.0	34.5	4,491.6	31.2	12,618.0	49.6	5,255.1		4,085.3	31.3	26,450.0	42.4	315,868.0	33.9
1975	381,286.0	37.4	6,030.2	36.3	14,605.9	49.4	5,772.4	53.6	4,753.1	31.0	31,161.6	43.1	350,124.4	36.9
1976	440,749.0	37.0	9,302.5	38.6	16,866.2	48.3	7,429.9	54.1	5,197.5	31.1	38,796.2	43.4	401,952.9	36.4
1977	496,403.0	37.5	10,401.0	39.1	19,146.8	47.4	8,815.8	54.1	5,831.0	31.2	44,194.6	43.3	452,208.4	37.0
1978	564,275.0	39.1	12,980.0	45.8	21,402.6	46.7	8,825.8		7,558.0	33.3	50,766.4	44.8	513,508.6	38.6
1979	635,601.0	38.1	13,802.0	45.0	25,020.7	43.2	9,718.4	51.3	8,308.0	34.4	56,849.1	42.5	578,751.9	37.7
1980	679,520.0	35.6	16,032.0	39.5	27,054.3	43.9	11,041.2	51.1	9,857.0	34.4	63,984.5	45.0	615,535.5	35.0
1981	733,461.0	34.8	20,108.0	37.9	30,620.0	45.3	13,287.8	9.09	11,377.0	33.3	75,392.8	41.6	658,068.2	34.1
1982	821,520.0	35.0	22,480.0	37.0	34,829.1	45.0	15,791.5	48.4	12,526.0	32.3	85,626.6	40.8	735,893.4	34.4
1983	900,970.0	35.6	27,250.0	40.8	39,133.7	43.2	18,105.4	45.2	15,256.0	34.2	99,745.1	41.2	801,224.9	35.0
1984	956,273.0	34.6	29,913.0	36.9	46,728.4	45.9	25,249.8	48.3	15,271.0	31.2	117,162.2	40.2	839,110.8	33.9
1985	1,033,130.0	35.3	31,005.0	38.1	49,149.9	41.0	28,660.3	47.6	16,247.9	30.0	125,063.1	39.6	908,066.9	34.8
1986	1,120,100.0	38.4	31,444.0	38.6	50,915.5	40.3	29,114.3		18,851.0		130,324.8	39.8	989,775.2	38.2
1987	1,143,220.0	38.1	30,661.0	36.8	54,579.1	40.5	27,852.4		20,368.0		133,460.5	39.5	1,009,759.5	37.9
1988	1,242,130.0	38.3	35,566.0	37.3	59,239.2	40.9	31,247.6	45.8	21,645.9	31.5	147,698.7	39.2	1,094,431.3	38.2
1989	1,324,620.0	37.3	38,809.0	35.0	62,245.9	39.4	33,131.6	43.6	21,884.0	29.1	156,070.5	37.2	1,168,549.5	37.3
1990	1,394,500.0	37.7	39,840.0	32.5	64,615.6	38.9	34,470.6		24,548.9	30.5	163,475.1	36.5	1,231,024.9	37.9
1991	1,409,770.0	37.7	39,877.0	32.0	66,026.1	37.4	34,360.4		25,742.9		166,006.4	35.6	1,243,763.6	38.0
1992	1,402,730.0	37.6	39,883.0	31.4	66,815.0	37.7	32,387.0		29,427.9	31.9	168,512.9	35.5	1,234,217.1	37.9
1993	1,380,290.0	38.7	40,646.0	33.6	66,032.0	38.2	28,850.0		32,935.8	33.9	168,463.8	36.5	1,211,826.2	39.0
1994	1,423,060.0	37.9	38,330.0	31.4	67,573.0	37.4	28,584.0		31,715.8	32.2	166,202.8	35.0	1,256,857.2	38.3
1995	1,478,010.0	37.6	42,874.0	34.7	71,080.0	37.2	29,687.0	38.0	32,670.0	31.2	176,311.0	35.4	1,301,699.0	37.9

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

Value (milir	l													•
natic	Value added value added/ (millions of production nat'l currency) (percent) ^a		Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added, production (percent) ^a
						United Kingdom	ingdom							
19701	14,839.0 3	31.3	474.6	78.5	546.5	36.9	117.6	32.3	226.3	3 42.5	1,365.1	45.7	13,473.9	30.4
197116	16,093.0	32.0	534.0	81.1	638.1	38.1	115.7		259.8	8 44.8	1,547.5	47.6	14,545.5	
197218		33.6	577.7	82.6	717.2	39.1	161.9		259.8	8 44.0	1,716.6	48.5	16,371.4	32.6
1973 20		33.1	0.909	79.8	840.9	37.8	181.8		292.1	1 41.0	1,920.8	45.7	19,048.2	32.2
1974 22		27.3	563.5	64.0	919.4	35.4	216.3		316.3	3 35.6	2,015.6	40.2	20,704.4	26.5
197527	27,657.0 2	29.7	764.3	69.2	1,136.4	39.7	301.0	39.6	412.2	2 39.3	2,614.0	45.3	25,043.0	28.7
1976 3-		28.2	842.4	38.5	1,223.2	35.4	271.1	30.9	474.0	0 37.6	2,810.7	36.1	29,072.3	27.6
197738	38,512.0 2	29.2	896.4	38.6	1,483.2	38.2	352.1	35.9	669.5	5 41.6	3,401.1	38.7	35,110.9	28.5
19784		31.2	1,046.4	39.8	1,805.7	40.4	433.7	38.4	808.6	6 43.2	4,094.3	40.6	40,491.7	30.5
197949		29.9	1,159.5	35.5	1,906.6	38.0	570.5		921.2	2 41.0	4,557.8	37.9	44,837.2	29.2
19805	54,144.0 3	30.7	1,727.3	37.1	2,407.2	40.4	642.0	40.5	1,107.7	7 45.4	5,884.2	40.2	48,259.8	29.8
1981 58	55,834.0 3	31.3	1,861.6	35.1	2,578.7	39.9	621.1	42.5	1,192.1	1 45.2	6,253.5	39.4	49,580.5	30.5
	61,158.0 3	32.3	2,004.2	37.7	3,051.5	42.5	771.6	44.4	1,493.2	2 49.0	7,320.4	42.4	53,837.6	31.3
	64,738.0 3	31.8	2,305.5	41.0	3,296.0	40.2	921.1	40.0	1,553.8	8 47.5	8,076.4	41.6	56,661.6	30.7
		30.3	2,139.2	36.8	3,890.0	38.6	1,111.6		1,725.8	8 47.0	8,866.6	38.8	59,767.4	
1985 76	76,801.0 3	31.7	2,228.8	33.1	4,222.1	40.0	1,509.1	35.1	1,988.4	4 49.3	9,948.3	38.8	66,852.7	30.8
		34.1	2,942.0	36.2	4,285.4	39.7	1,499.9	36.5	2,182.4	4 49.3	10,909.7	39.7	71,512.3	
198789		33.1	3,028.1	34.1	4,459.8	38.5	1,791.9		2,526.0	0 50.3	11,805.7	38.5	78,096.3	32.5
1988 100		33.5	3,394.6	37.2	4,972.2	39.1	2,302.6		2,939.6	6 51.4	13,609.0	39.6	86,623.1	32.8
1989107	107,166.0 3	32.9	4,200.7	38.6	4,867.5	35.8	2,398.2	30.6	3,175.9	0.05 6	14,642.2	37.9	92,523.8	32.2
199011	11,315.0	32.9	5,078.3	42.7	4,914.4	35.2	2,465.8	29.7	3,493.2		15,951.6	38.9	95,363.4	32.0
1991106	106,896.0	32.6	4,770.9	39.6	4,744.9	36.2	2,331.7	28.1	3,801.1		15,648.6	38.2	91,247.5	31.8
1992109	09,071.0	32.2	3,818.5	28.9	4,790.2	36.2	2,093.1		4,216.0		14,917.8	34.0	94,153.2	31.9
199311	13,940.0	32.7	Ϋ́	Ϋ́	Ϋ́	Ϋ́	AN AN	N	AN	A N	₹ Z	N A	Ϋ́	¥
199412	21,272.0 3	32.4	Ϋ́	Ϋ́	Ϋ́	Ν	ΑN	¥Z	NA	A N	Ϋ́	Ν	NA	¥
1995128	28,631.0	32.4	N	¥	Ϋ́	Ν	AN	NA	NA		AN AN	Α	NA	Α̈́

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

Maintane de la mate andere de la materia de		Total manufacturing	ıfacturing	Airc	Aircraft	Communications	Ications	Office & computers	mputers	Drugs & medicines	edicines	High-tech manutacturing	anutacturing	Otner manutacturing	racturing
18105.0000 364 10,424.0 30.4 51,451.0 47.3 415,480.0 56.5 388,587.0 32.5 1,321,734.4 42.6 16,782,266.5 20.5 1,942,000.0 36.4 110,424.0 30.4 51,872.0 48.5 389,545.0 52.4 1,324,605.0 32.4 1,374,605.0 42.0 110,424.0 30.4 51,872.0 48.5 389,545.0 66.2 40.2 32.4 1,374,605.0 42.0 110,424.0 30.1 51,828.0 30.1 51,828.0 66.2 40.2 50.0 32.5 1,374,605.0 42.0 110,424.0 30.1 51,828.0 30.1 51,828.0 66.2 40.2 50.0 32.5 1,374,605.0 42.0 110,424.0 30.1 51,828.0 30.1 51,828.0 67.7 227,590.0 67.1 50,225.0 43.9 1,424,215.0 47.3 31,323,04.0 46.5 31,229.0 67.1 50,225.0 43.9 1,424,215.0 47.3 31,313,04.0 46.5 31,229.0 67.1 50,225.0 43.9 1,424,215.0 47.3 31,313,04.0 46.5 31,229.0 67.1 50,225.0 43.9 1,424,215.0 47.3 31,915.0 67.0 47.2 51,229.0 67.0 47.3 31,915.0 67.0 47.3 31,915.0 47.2 51,229.0 67.0 47.3 31,915.0 47.2 51,229.0 67.0 47.3 31,915.0 47.2 51,229.0 47.2 51,239.0 47.2 51		Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a		Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a		Value added, production (percent) ^a
16,105,0000 36.4 92,206.4 30.8 455,461.0 47.3 415,480.0 56.5 366,415.0 22.0 132,1734.0 4.6 16,705,000 36.4 110,424.0 30.4 517,275.0 48.4 227,580.0 69.7 227,580.0 37.0 41,424.136.0 30.1 41,424.0 30.1 41,424.0 30.1 41,424.0 30.1 41,424.0 30.1 41,424.0 30.1 41,424.0 40.0 41,420.0 42.0 41,420.0 42.0 42,40.3 41,430.0 40.0 41,420.0 41,40.0 40.0 41,40.0 40.0 41,40.0 40.0 41,40.0 40.0 41,40.0 40.0 41,40.0							 	aly							
146420000 364 1110,424.0 30.4 518,672,90 48.5 386,546.0 61.4 366,415.0 32.8 1386,165.0 42.9 18,066,500 21,016,0000 36.5 116,924.0 30.1 572,576.0 64.4 202,055.0 32.4 1,374,605.0 43.7 21,046,000 36.6 116,924.0 30.5 148,285.0 28.7 275,600 67.1 502,055.0 34.9 172,750 48.4 172,750 64.4 606,728.0 43.4 1,724,215.0 43.7 21,893,980 38.4 39,900,950 39.6 41,424,215.0 43.7 24,900,900 39.6 41,486,780 43.7 44.8 41,486,780 44.8 41,744,715.0 43.7 41,486,780 44.8 41,744,715.0 43.7 41,486,780 44.8 41,744,715.0 43.7 41,486,800 44.8 41,486,716.0 41,77 44,486,716.0 41,77 44,486,716.0 41,77 44,486,716.0 41,77 44,486,716.0 41,77 44,486,716.0 41,77 44,486,716.0	1970	18,105,000.0	36.4	92,206.4	30.8	455,451.0	47.3	415,480.0		358,597.0		1,321,734.4	42.6	16,783,265.6	36.0
21,016,0000 36. 116,892.0 30. 37,240.0 48.4 222,691.0 61.4 402,055.0 3.24 1374,665.0 42.0 19,641,360.0 26,00000 36.6 115,882.0 28.6 115,882.0 67.7 227,590.0 67.4 402,055.0 43.9 1,424,215.0 47.3 31,543,040.0 38,490,1000 36.6 116,882.80 28.5 1,589,000 42.5 117,745,860 43.9 1,474,215.0 43.9 1,475,860.0 47.3 31,343,940.0 38,490,1000 36.6 226,542.0 22.5 1,589,200 42.5 1,417,100 66.7 43.9 43.2 43.5 33,390,570 43.6 43.6 43.6 43.6 43.6 43.6 43.6 43.2 43.6 43.6 43.6 43.2	1971	19,452,000.0	36.4	110,424.0	30.4	518,762.0	48.5	369,564.0		386,415.		1,385,165.0	42.9	18,066,835.0	36.0
26,064,0000 36,6 115,832,0 28,2 6604,030 66,7 40,390,030 66,2 44,215,0 43,9 1,424,215,0 43,7 26,083,000 4,490,0000 36,6 205,451,0 30,0 312,219,0 64,9 7,756,000 43,9 1,775,680 43,3 31,283,040 4,490,0000 36,6 205,432,0 27,1 1,269,380 42,5 411,4 2,604,433 43,6 36,056,70 4,490,0000 36,6 205,430 27,7 1,269,380 312,710 68,2 889,007 41,3 3,605,640 43,6 36,056,70 42,5 411,660 60,7 769,069 42,3 1,774,800 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 42,3 41,74,210 <	1972	21,016,000.0	36.5	116,961.0	30.1	572,976.0	48.4	282,613.0		402,055.0		1,374,605.0	42.0	19,641,395.0	36.1
44911 000.0 35 5 148,2850 31 0 84,551.0 489 57.1 48,560.0 67.1 502,220 4.3 1,772,896 4.7 33,108,307.0 51,06,000.0 36.6 255,450.0 2.6 1,596,000.0 36.6 255,450.0 2.7 1,596,000.0 36.6 255,450.0 2.7 1,593,800.0 3.6 41,566,000.0 36.6 255,450.0 2.7 1,593,800.0 3.6 41,566,000.0 36.6 497,508.0 2.9 1,593,800.0 3.6 407,608.0 2.9 1,593,800.0 3.6 407,508.0 3.6 407,508.0 3.6 407,508.0 3.6 407,508.0 3.6 407,508.0 3.6 407,508.0 3.7 7,72,525.0 4.2 4.2 4.75,480.0 3.8 4.88,471.0 5.8 3.66,539.0 3.8 4.88,471.0 4.8 3.66,530.0 3.8 3.8 4.8 5.66,520.0 3.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8 4.8	1973	26,064,000.0	36.6	115,832.0	28.2	660,403.0	20.7	227,590.0		420,390.0		1,424,215.0	43.7	24,639,785.0	36.2
384380000 36.6 205515.0 27.1 990,971.0 46.5 312,219.0 64.4 606,728.0 41.4 2.054,33.0 43.6 36,390,567.0 41.8 51,826,000.0 36.6 437,420.0 37.5 1,191,56.0 60.7 789,089.0 42.2 3,171,66.0 40.7 789,089.0 42.2 3,171,66.0 40.7 48,730,16.0 41.3 3,131,66.0 41.3 3,131,66.0 41.2 48,730,16.0 41.3 3,131,66.0 41.3 3,131,66.0 41.2 48,730,16.0 41.3 3,131,66.0 41.2 48,730,16.0 48,730,14.0 48.8 41,10.1 48,730,16.0	1974	34,901,000.0	36.5	148,263.0	30.0	846,521.0	49.9	275,660.0		502,252.1		1,772,696.0	47.3	33,128,304.0	36.1
51,506,000.0 36.6 325,492.0 27.9 1,289,380.0 42.5 411,565.0 60.7 789,089.0 42.3 2,775,486.0 41.7 48,730,514.0 61,820,000.0 36.6 486,565.0 1,586,700.0 36.6 486,750.0 41.9 3,540,760.0 41.7 48,735,700.0 41.7 48,745,700.0 41.7 48,745,700.0 41.7	1975	38,436,000.0	36.6	205,515.0	27.1	920,971.0	46.5	312,219.0		606,728.0		2,045,433.0	43.6	36,390,567.0	36.2
61,882,000.0 366 497,608.0 295 1,583,880.0 396 488,671.0 56.2 833,007.0 41.3 3181,166.0 40.2 58,42,834.0 71,493,000.0 36.6 495,956.0 26.1 1,568,920.0 37.5 541,710.0 56.8 986,175.0 41.9 3,600,760.0 38.2 67,802.2 81,393,000.0 36.6 797,661.0 27.5 1,114,270.0 55.1 1,655,330.0 45.0 5,666,260.0 38.2 67,802.40.0 10,419,000.0 36.0 1,111,630.0 27.7 1,114,270.0 55.1 1,655,330.0 45.0 5,666,260.0 38.2 67,806.42.0 10,419,000.0 36.0 1,111,630.0 27.7 1,114,270.0 55.1 1,252,240.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,300.0 38.3 1,117,400.0 38.3 1,117,300.0	1976	51,506,000.0	36.6	325,492.0	27.9	1,269,360.0	42.5	411,565.0		769,069.1		2,775,486.0	41.7	48,730,514.0	36.3
71,459,0000 36.6 495,955.0 26.1 1,626,920.0 37.5 541,710.0 56.8 986,175.0 41.9 3,650,760.0 38.2 67,808,240.0 87,335,000.0 36.6 628,340.0 27.5 1,916,120.0 37.5 1,191,270.0 42.2 4,506,295.0 38.2 67,808,240.0 107,923,000.0 36.6 1,191,630.0 27.5 2,167,300.0 37.7 1,174,270.0 55.1 4.8 6,809,150.0 38.3 117,309,850.0 140,322,000.0 36.6 1,448,060.0 31.2 4,114,330.0 57.7 1,474,270.0 55.7 2,292,240.0 43.2 6,809,150.0 38.3 177,309,850.0 140,332,000.0 35.6 1,448,060.0 36.4 4,602,440.0 54.2 2,047,180.0 59.3 3,977,200.0 54.1 1,73,309,850.0 1,73,309,850.0 1,73,309,850.0 1,73,309,850.0 1,73,309,850.0 1,73,309,850.0 1,73,309,850.0 1,74,42,420.0 3,8 4,745,400.0 4,8 4,745,400.0 4,8 1,744,700.0 3,8 4,	1977	61,862,000.0	36.6	407,608.0	29.5	1,583,880.0	39.6	488,671.0		839,007.		3,319,166.0	40.2	58,542,834.0	36.4
87,935,000.0 36.6 626,340.0 27.5 1,916,120.0 37.8 772,625.0 58.3 1,191,210.0 42.2 4,506,295.0 39.2 83,428,705.0 107,923,000.0 36.6 73,61.0 25.6 2,152,840.0 37.7 1,174,270.0 55.1 1,655,330.0 46.0 5,666,286.0 38.5 102,356,742.0 124,119,000.0 36.0 1,191,630.0 25.7 2,617,300.0 37.7 1,174,270.0 55.1 1,655,330.0 46.0 5,666,286.0 38.5 102,356,742.0 144,119,000.0 36.0 1,448,060.0 24.0 3,175,750.0 36.2 2,047,180.0 55.7 2,292,240.0 43.2 3,605,450.0 36.1 1,448,076.0 36.1 1,448,076.0 36.2 3,600,430.0 43.0 4,448,076.0 36.2 3,600,430.0 43.7 3,600,430.0 56.2 3,600,430.0 43.7 3,600,430.0 43.7 3,600,430.0 43.7 3,600,430.0 43.7 3,600,430.0 43.7 3,600,430.0 43.7 3,600,430.0 43.7	1978	71,459,000.0	36.6	495,955.0	26.1	1,626,920.0	37.5	541,710.0		986,175.0		3,650,760.0	38.2	67,808,240.0	36.5
107,923,000.0 36.6 797,661.0 25.6 2,152,840.0 35.7 1,174,270.0 57.3 1,655,330.0 46.0 5,566,258.0 38.6 102,356,742.0 124,119,000.0 36.0 1,191,630.0 25.7 2,617,300.0 37.7 1,174,270.0 55.1 1,825,950.0 44.8 6,809,150.0 38.3 117,309,850.0 140,3932,000.0 35.6 1,448,060.0 24.0 3,175,750.0 34.8 1,451,200.0 53.7 2,292,240.0 43.2 8,367,250.0 36.1 132,564,750.0 156,417,000.0 35.6 1,574,680.0 36.4 4,602,440.0 51.9 1,685,190.0 62.5 3,600,430.0 51.0 145,442,370.0 156,417,000.0 36.2 1,574,680.0 36.4 4,602,440.0 51.9 1,645,170.0 53.7 1,243,280.0 36.1 145,442,370.0 196,484,000.0 36.2 2,247,080.0 36.5 5,306,900.0 44.9 2,744,680.0 48.9 1,644,42,370.0 14.1 1,444,070.0 14.1 1,445,400.0	1979	87,935,000.0		626,340.0	27.5	1,916,120.0	37.8	772,625.0		1,191,210.		4,506,295.0	39.2	83,428,705.0	36.5
124,119,000.0 36.0 1,191,630.0 25.7 2,617,330.0 37.7 1,174,270.0 55.1 1,825,950.0 44.8 6,809,150.0 38.3 117,309,850.0 140,392,000.0 35.6 1,448,060.0 24.0 3,175,750.0 34.8 1,451,200.0 53.7 2,292,240.0 43.2 8,607,450.0 36.1 132,564,750.0 156,417,000.0 35.6 1,574,680.0 31.2 4,114,330.0 51.9 1,685,190.0 62.5 3,600,430.0 61.4 10,974,630.0 36.1 132,564,750.0 176,417,000.0 35.6 1,574,680.0 36.4 4,602,440.0 51.3 1,745,400.0 50.2 14,745,400.0 51.0 14,442,370.0 213,684,000.0 35.9 2,247,060.0 46.3 2,751,730.0 76.4 4,745,400.0 50.2 14,242,370.0 14,441,530.0 25.9 14,441,530.0 30.9 4,386,940.0 46.7 1,741,600.0 30.2 14,242,320.0 41.1 14,441,530.0 14,441,400.0 30.2 14,242,3280.0 30.4 14,441,530.0	1980	107,923,000.0	36.6	797,661.0	25.6	2,152,840.0	35.7	960,427.0		1,655,330.0		5,566,258.0	38.6	102,356,742.0	36.5
140,932,000.0 35.6 1,448,060.0 24.0 3,175,750.0 34.8 1,451,200.0 63.7 2,292,240.0 43.2 8,367,250.0 36.1 132,564,750.0 156,417,000.0 35.6 1,574,680.0 31.2 4,114,330.0 51.9 1,685,190.0 62.5 3,600,430.0 61.4 10,974,630.0 51.0 145,442,370.0 156,417,000.0 35.6 1,574,680.0 36.4 4,602,440.0 54.2 2,047,180.0 59.3 3,977,200.0 54.9 12,334,450.0 51.0 145,442,370.0 196,484,000.0 36.2 2,247,060.0 36.5 5,306,900.0 45.0 2,751,730.0 76.4 4,745,400.0 50.2 142,43,280.0 51.7 146,6442,370.0 213,686,000.0 35.9 2,247,060.0 36.5 5,306,900.0 45.0 2,751,730.0 30.9 4,986,940.0 48.7 142,43,280.0 41.2 148,441,530.0 256,378,000.0 35.9 6,619,280.0 40.0 3,106,570.0 24.7 NA NA NA NA	1981	124,119,000.0	36.0	1,191,630.0	25.7	2,617,300.0	37.7	1,174,270.0		1,825,950.0		6,809,150.0	38.3	117,309,850.0	35.9
156,417,000.0 35.6 1,574,680.0 31.2 4,114,330.0 51.9 1,685,190.0 62.5 3,600,430.0 61.4 10,974,630.0 51.0 145,442,370.0 176,942,000.0 34.2 1,707,630.0 36.4 4,602,440.0 54.2 2,047,180.0 59.3 3,977,200.0 54.9 12,334,450.0 51.7 164,607,550.0 196,484,000.0 34.2 1,707,630.0 36.5 5,306,900.0 45.0 2,751,730.0 30.9 4,386,940.0 50.2 14,243,280.0 51.7 164,607,550.0 213,686,000.0 35.9 2,247,060.0 36.5 5,306,900.0 46.4 2,914,680.0 31.5 5,598,060.0 48.7 16,5292,630.0 41.1 213,441,530.0 256,378,000.0 35.9 2,247,060.0 35.9 6,619,280.0 40.0 3,106,570.0 24.7 NA NA NA NA 256,378,000.0 34.9 3,244,500.0 45.2 7,884,310.0 40.0 3,106,570.0 24.7 NA NA NA NA	1982	140,932,000.0	35.6	1,448,060.0	24.0	3,175,750.0	34.8	1,451,200.0		2,292,240.1		8,367,250.0	36.1	132,564,750.0	35.6
176,942,000.0 34.2 1,707,630.0 36.4 4,602,440.0 54.2 2,047,180.0 59.3 3,977,200.0 54.9 12,334,450.0 51.7 164,607,550.0 196,484,000.0 34.2 1,707,630.0 26.8 4,901,630.0 41.9 2,732,170.0 76.4 4,745,400.0 50.2 14,243,280.0 45.0 182,240,720.0 213,686,000.0 35.9 2,247,060.0 36.5 5,306,900.0 45.0 2,751,730.0 30.9 4,986,940.0 48.5 15,292,630.0 47.2 198,393,370.0 256,378,000.0 35.8 2,516,800.0 46.4 2,914,680.0 31.5 5,598,060.0 43.0 18,244,500.0 47.2 198,393,370.0 256,378,000.0 35.8 6,619,280.0 46.4 2,914,680.0 31.2 NA NA NA NA 278,654,000.0 35.8 6,619,280.0 46.3 3,308,120.0 31.2 14,243,280.0 47.1 213,441,530.0 286,322,000.0 35.8 6,619,280.0 40.0 3,106,570.0	1983	156,417,000.0	35.6	1,574,680.0	31.2	4,114,330.0	51.9	1,685,190.0		3,600,430.0		10,974,630.0	51.0	145,442,370.0	34.8
196,484,000.0 34.2 1,864,080.0 26.8 4,901,630.0 41.9 2,732,170.0 76.4 4,745,400.0 50.2 14,243,280.0 45.0 182,240,720.0 213,686,000.0 35.9 2,247,060.0 36.5 5,306,900.0 45.0 2,751,730.0 30.9 4,986,940.0 48.5 15,292,630.0 41.2 198,393,370.0 230,093,000.0 35.8 2,247,060.0 36.9 6,619,280.0 46.4 2,914,680.0 24.7 NA NA <td< td=""><td>1984</td><td>176,942,000.0</td><td>34.2</td><td>1,707,630.0</td><td>36.4</td><td>4,602,440.0</td><td>54.2</td><td>2,047,180.0</td><td></td><td>3,977,200.1</td><td></td><td>12,334,450.0</td><td>51.7</td><td>164,607,550.0</td><td>33.4</td></td<>	1984	176,942,000.0	34.2	1,707,630.0	36.4	4,602,440.0	54.2	2,047,180.0		3,977,200.1		12,334,450.0	51.7	164,607,550.0	33.4
213,686,000.0 35.9 2,247,060.0 36.5 5,306,900.0 45.0 2,751,730.0 30.9 4,986,940.0 48.5 15,292,630.0 41.2 198,393,370.0 230,093,000.0 35.8 2,247,060.0 36.9 6,619,280.0 46.4 2,914,680.0 31.5 5,598,060.0 43.0 16,651,470.0 41.1 213,441,530.0 256,378,000.0 34.8 2,567,880.0 46.2 7,884,310.0 49.3 3,308,120.0 24.7 NA NA NA NA NA 293,622,000.0 34.3 3,544,500.0 46.5 8,606,650.0 51.1 2,886,320.0 24.9 NA NA NA NA 300,246,000.0 34.3 3,244,500.0 46.5 8,606,650.0 51.1 2,886,320.0 22.9 NA NA NA NA 300,246,000.0 35.5 NA 8,883,320.0 52.5 2,904,940.0 30.3 NA NA NA NA 310,429,000.0 35.3 NA NA NA<	1985	196,484,000.0	34.2	1,864,080.0	26.8	4,901,630.0	41.9	2,732,170.0		4,745,400.1		14,243,280.0	45.0	182,240,720.0	33.5
230,093,000.0 35.8 2,321,930.0 40.3 5,816,800.0 46.4 2,914,680.0 31.5 5,598,060.0 43.0 16,651,470.0 41.1 213,441,530.0 256,378,000.0 34.8 2,567,880.0 35.9 6,619,280.0 40.0 3,106,570.0 24.7 NA NA <t< td=""><td>1986</td><td>213,686,000.0</td><td>32.9</td><td>2,247,060.0</td><td>36.5</td><td>5,306,900.0</td><td>42.0</td><td>2,751,730.0</td><td></td><td>4,986,940.</td><td></td><td>15,292,630.0</td><td>41.2</td><td>198,393,370.0</td><td>35.6</td></t<>	1986	213,686,000.0	32.9	2,247,060.0	36.5	5,306,900.0	42.0	2,751,730.0		4,986,940.		15,292,630.0	41.2	198,393,370.0	35.6
256,378,000.0 34.8 2,567,880.0 35.9 6,619,280.0 40.0 3,106,570.0 24.7 NA NA NA NA NA 279,654,000.0 33.8 3,273,600.0 46.5 7,884,310.0 49.3 3,308,120.0 31.2 NA NA NA NA 293,622,000.0 34.3 3,544,500.0 46.5 8,608,650.0 51.1 2,886,320.0 24.9 NA NA NA NA NA 300,246,000.0 34.9 3,285,340.0 45.9 8,860,790.0 52.5 2,904,940.0 30.3 NA NA NA NA 307,906,000.0 35.5 NA NA NA NA NA NA NA 331,620,000.0 35.3 NA NA NA NA NA NA NA NA 331,620,000.0 34.2 NA NA NA NA NA NA NA NA 331,620,000.0 34.2 NA NA	1987	230,093,000.0	35.8	2,321,930.0	40.3	5,816,800.0	46.4	2,914,680.0		5,598,060.0		16,651,470.0	41.1	213,441,530.0	35.4
279,654,000.0 33.8 3,273,600.0 45.2 7,884,310.0 49.3 3,308,120.0 31.2 NA NA NA NA NA 293,622,000.0 34.3 3,544,500.0 46.5 8,608,650.0 51.1 2,886,320.0 24.9 NA NA NA NA NA 300,246,000.0 34.9 3,285,340.0 45.9 8,860,790.0 52.5 2,904,940.0 30.3 NA NA NA NA 307,906,000.0 35.5 NA NA NA NA NA NA NA 331,620,000.0 35.3 NA NA NA NA NA NA 331,620,000.0 34.2 NA NA NA NA NA NA NA 331,620,000.0 34.2 NA NA NA NA NA NA 389,033,000.0 34.2 NA NA NA NA NA NA	1988	256,378,000.0	34.8	2,567,880.0	32.9	6,619,280.0	40.0	3,106,570.0		Ż		NA	¥	AN	
283,622,000.0 34.3 3,544,500.0 46.5 8,608,650.0 51.1 2,886,320.0 24.9 NA <	1989	279,654,000.0	33.8	3,273,600.0	45.2	7,884,310.0	49.3	3,308,120.0		Ż		Ϋ́	¥	Ν	Ϋ́
300,246,000.0 34.9 3,285,340.0 45.9 8,860,790.0 52.5 2,904,940.0 30.3 NA <	1990	293,622,000.0		3,544,500.0	46.5	8,608,650.0	51.1	2,886,320.0		Ž		NA	Ą	AN	N
307,906,000.0 35.5 NA NA 8,883,320.0 54.2 3,167,660.0 32.5 NA	1991	300,246,000.0		3,285,340.0	45.9	8,860,790.0	52.5	2,904,940.0		Ż		NA	¥	AN	Ϋ́
	1992	307,906,000.0		Y V	Ϋ́	8,883,320.0	54.2	3,167,660.0		Ż		N	Ϋ́	AN	Ϋ́
	1993	310,429,000.0	35.3	N	Ϋ́	8,520,540.0	53.5	3,085,930.0		Ż		N	Ϋ́	AN	Ϋ́
	1994	331,620,000.0		N	¥	A A	NA	AN		Ż		NA	¥	AN	Ϋ́
	1995	369,033,000.0	33.1	Y Y	ΑN	Y V	N	A A A		Ż		Ą	Ϋ́	Ϋ́	Ν

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Airc	Aircraft	Communications	ications	Office & computers	mputers	Drugs & medicines	dicines	High-tech manufacturing	nufacturing	Other manufacturing	acturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added Value in (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						South	South Korea							
1970	581,700.0	25.8	NA	Ą	16,885.7	40.7	312,745.0	36.2	11,706.0	39.2	341,336.7	36.5	240,363.3	18.2
1971	721,900.0	24.7	Ϋ́	N	25,898.1	39.5	327,933.0	38.1	16,206.0	40.6	370,037.1	38.3	351,862.9	18.0
1972	937,000.0	25.0	Ϋ́	N	39,020.8	33.7	365,772.0	39.5	17,120.5	36.4	421,913.3	38.8	515,086.7	19.4
1973	1,350,200.0	25.0	Ϋ́	NA	76,210.2	30.5	449,269.0	35.6	20,159.1	35.0	545,638.3	34.8	804,561.7	21.0
1974	1,970,300.0	23.2	Ϋ́	N	154,792.0	34.0	581,084.0	36.1	34,424.8	40.4	770,300.8	35.9	1,199,999.2	19.0
1975	2,665,300.0	24.1	Ϋ́	N	202,702.0	36.8	556,282.0	36.9	58,688.5	36.7	817,672.5	36.9	1,847,627.5	20.9
1976	3,862,400.0	25.3	Ϋ́	NA	307,050.0	32.8	600,145.0	39.2	84,443.9	43.2	991,638.9	37.2	2,870,761.1	22.7
1977	4,837,300.0	25.3	Ϋ́	NA	327,563.0	32.2	726,608.0	33.5	112,835.0	44.7	1,167,006.0	34.0	3,670,294.0	23.4
1978	6,513,900.0	25.3	Ϋ́	NA	436,609.0	28.4	836,794.0	33.5	148,212.0	45.2	1,421,615.0	32.6	5,092,285.0	23.9
1979	8,644,800.0	24.6	N	Ν	608,218.0	29.0	989,708.0	33.7	176,438.0	40.3	1,774,364.0	32.4	6,870,436.0	23.2
1980	10,743,100.0	22.8	NA	N A	700,517.0	29.7	1,179,570.0	33.5	266,539.0	43.4	2,146,626.0	33.0	8,596,474.0	21.2
1981	13,566,700.0	22.8	Ϋ́	NA	921,156.0	29.8	1,335,990.0	32.4	290,042.0	41.8	2,547,188.0	32.2	11,019,512.0	21.4
1982	15,376,400.0	23.2	Ϋ́	NA	974,522.0	29.8	1,542,630.0	34.0	380,122.0	44.7	2,897,274.0	33.5	12,479,126.0	21.7
1983	18,637,000.0	24.3	Ϋ́	Ν	1,358,180.0	30.2	1,986,090.0	34.3	456,738.0	46.9	3,801,008.0	33.7	14,835,992.0	22.6
1984	21,989,100.0	24.6	Ϋ́	Y Y	1,890,080.0	30.9	2,342,440.0	32.7	517,734.0	45.7	4,750,254.0	32.9	17,238,846.0	23.0
1985	24,080,000.0	24.8	Ϋ́	Y Y	1,958,250.0	30.9	2,853,440.0	35.6	558,327.0	45.0	5,370,017.0	34.4	18,709,983.0	23.0
1986	29,449,400.0	25.5	¥Z	NA	2,722,600.0	28.1	2,912,310.0	36.6	681,001.0	50.1	6,315,911.0	33.2	23,133,489.0	24.0
1987	35,173,500.0	25.1	Ϋ́	Y V	3,471,710.0	25.2	2,895,760.0	34.6	734,021.0	9.09	7,101,491.0	30.1	28,072,009.0	24.0
1988	42,679,200.0	26.3	Ϋ́	NA	4,395,730.0	26.1	3,117,800.0	34.6	989,079.0	46.5	8,502,609.0	30.4	34,176,591.0	25.4
1989	46,252,900.0	56.6	Ϋ́	N	4,896,630.0	28.8	3,535,620.0	34.9	931,269.0	49.9	9,363,519.0	32.3	36,889,381.0	25.5
1990	52,351,000.0	26.5	N	N A	5,855,520.0	30.8	3,946,330.0	35.0	923,660.0	38.7	10,725,510.0	32.8	41,625,490.0	25.3
1991	61,527,300.0	27.5	¥Z	NA	6,687,980.0	32.1	4,218,600.0	34.4	1,182,850.0	43.3	12,089,430.0	33.7	49,437,870.0	26.3
1992	66,711,400.0	27.7	Ϋ́	Y Y	6,947,920.0	32.4	4,007,420.0	33.7	1,357,870.0	43.7	12,313,210.0	33.8	54,398,190.0	56.6
1993	72,162,400.0	28.4	Ϋ́	Y Y	8,655,490.0	35.6	3,430,760.0	31.7	1,491,550.0	44.5	13,577,800.0	35.3	58,584,600.0	27.2
1994	82,131,900.0	29.1	Ϋ́	Y Y	10,401,400.0	36.0	3,189,820.0	34.2	1,669,010.0	47.2	15,260,230.0	36.5	AN A	¥
1995	94,484,800.0	Ϋ́	N A	Y Y	¥.	A V	ΑN	NA	¥ V V	Ϋ́	₹ Z	Ϋ́	Ϋ́	Ϋ́
0 9- 1														

High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95 Appendix table 6-4.

	Total manufacturing	facturing	Aircraft	raft	Communications	cations	Office & computers	mputers	Drugs & medicines	dicines	High-tech manufacturing	nufacturing	Other manufacturing	facturing
	Value added (millions of nat'l currency)	Value added/ production (percent)a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added V (millions of nat'l currency)	Value added/ production (percent)a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						Spi	Spain							
1970	579,816.0	25.4	NA	NA	NA	NA	NA	NA	11,914.3	28.4	NA	NA	NA	N
1971	656,537.0	25.9	Ϋ́	¥	NA	N	AN	Ϋ́	11,983.0		NA	ΑĀ	NA	¥
1972	810,781.0	26.8	Ϋ́	¥	AN	NA	ΑN	¥	16,409.0	24.8	NA	Ν	AN	Α
1973	1,005,790.0	27.4	ΑN	¥	NA	NA	AN	Ϋ́	21,130.4	26.7	NA	ΑĀ	AN	Α
1974	1,281,930.0	26.1	Ϋ́	¥	NA	N	AN	Ϋ́	25,830.8	29.4	NA	ΑĀ	AN	¥
1975	1,430,960.0	27.1	Ϋ́	¥	NA	NA	A A	¥	29,614.5	31.3	NA	Ν	NA	ΑN
1976	1,713,390.0	27.5	Ϋ́	¥	NA	NA	A A	¥	33,523.4		NA	Ν	NA	ΑN
1977	2,148,850.0	28.6	Ϋ́	¥	AN	NA	AN	¥	43,109.3	36.8	NA	Ν	NA	Α
1978	3,719,230.0	36.3	7,873.2	9.79	92,189.6	47.0	6,791.4	55.9	73,576.0	49.1	180,430.2	48.8	3,538,799.8	35.8
1979	4,229,370.0	36.8	10,448.9	6.97	94,687.3	48.4	8,194.6	53.0	87,042.0	51.9	200,372.8	51.1	4,028,997.2	36.3
1980	4,977,920.0	36.0	13,242.0	9.89	109,189.0	56.1	8,804.9	42.0	99,517.8	49.2	230,753.7	52.8	4,747,166.3	35.5
1981	5,321,120.0	35.8	18,693.7	65.8	113,029.0	56.9	14,861.5	43.8	121,279.0	52.6	267,863.2	54.5	5,053,256.8	35.1
1982	5,779,520.0	36.5	22,084.0	57.4	133,100.0	53.7	18,439.4	41.0	135,298.0		308,921.4	52.4	5,470,598.6	35.9
1983	6,541,970.0	36.4	25,394.5	64.2	155,770.0	55.0	20,476.0	48.9	147,872.0	53.1	349,512.5	54.3	6,192,457.5	35.7
1984	6,963,460.0	35.9	21,629.7	2.79	156,185.0	51.5	34,914.9	33.3	154,368.0		367,097.6	50.8	6,596,362.4	35.3
1985	7,531,800.0	36.2	26,964.2	70.2	154,470.0	50.2	42,962.5	30.1	187,252.0	55.6	411,648.7	49.8	7,120,151.3	35.7
1986	8,322,400.0	40.3	30,872.1	66.5	134,133.0	45.3	34,880.2	29.6	192,557.0		392,442.3	46.6	7,929,957.7	40.0
1987	9,029,700.0	40.7	35,729.1	60.2	144,252.0	44.3	31,444.4	29.4	217,789.0		429,214.5	46.7	8,600,485.5	40.5
1988	9,679,100.0	40.5	56,535.0	70.0	182,952.0	46.2	45,087.5	36.0	251,587.0	52.0	536,161.5	49.4	9,142,938.5	40.1
1989	10,675,100.0	40.3	58,861.1	61.6	221,873.0	44.3	55,574.4	42.4	320,233.0	54.5	656,541.5	20.0	10,018,558.5	39.8
1990	11,346,300.0	40.6	76,298.3	9.99	264,633.0	45.7	45,462.4	42.9	377,487.0	57.1	763,880.7	52.3	10,582,419.3	39.9
1991	12,011,700.0	40.9	61,303.8	63.9	240,803.0	46.0	64,162.5	41.0	453,695.0	57.5	819,964.3	52.4	11,191,735.7	40.3
1992	12,380,800.0	42.4	73,806.6	6.79	190,498.0	43.3	35,097.2	26.8	556,604.0	67.9	856,005.8	54.7	11,524,794.2	41.7
1993	12,653,100.0	43.1	Ą V	¥	229,692.0	44.2	56,937.3	38.1	526,134.0		NA	Ν Α	A A	¥
1994	13,993,500.0	44.0	N	Ϋ́	269,982.0	44.4	67,821.5	39.5	638,410.0	9.99	Ϋ́	Α	Ϋ́	¥
1995	16,293,000.0	45.5	N	Ϋ́	A N	NA	AN	Ϋ́	AN AN	N N	A A	Ν	AN	Ϋ́

NA = not available

NOTE: For U.S. value added, the Organisation for Economic Co-operation and Development reports data supplied by the U.S. Bureau of Economic Analysis on "Gross Product Originating."

"The production data used in this calculation are valued in national currency and are maintained by the Organisation for Economic Co-operation and Development in its Structural Analysis Database. These data do not match the production data provided in appendix table 6-5, which are valued in 1987 U.S. dollars.

SOURCE: Organisation for Economic Co-operation and Development, Structural Analysis Database (1996 edition).

See text table 6-2.

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Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						All n	All manufacturing industries	ing industr	ies							
Production All countries ^a	7,754,045	8,144,508	8,063,357	8,289,382	8,891,805	9,044,120	9,136,926	9,536,219	10,117,377	10,496,222	10,617,686	10,698,977	10,757,128	10,722,920	11,239,430	11,647,170
United States	2,070,477	2,201,960	2,077,227	2,143,027	2,326,374	2,282,612	2,300,127	2,465,600	2,568,882	2,553,131	2,544,395				2,859,185	2,949,769
Canada	173,666	188,763	173,291	183,293	208,511	222,268	230,649	237,541	247,747	243,392	229,974	217,454	223,449	242,460	256,594	267,526
Gorman, b	1,307,023	1,400,040	1,330,469	7004,040	750 242	700 416	704,699	70.062	1,090,321	2,034,442	2,100,303	708,010,7	047 550	2,002,010	4 069 794	2,149,120
France	435,143	461,449	478,474	479.285	495.137	501.172	497,227	499,816	524,458	555,932	567,715	571,754	569.432	533,252	554,404	570.845
United Kingdom	348,576	339,809	345,213	358,294	389,559	402,759	400,410	422,852	438,471	448,461	445,029	410,934	435,123	432,630	454,420	472,542
Italy	303,334	312,897	304,996	319,591	347,187	342,220	338,427	345,702	366,457	376,611	366,952	361,669	355,602	347,457	355,722	367,267
China	262,631	243,072	237,225	249,783	244,522	249,616	249,996	274,338	339,767	384,841	313,891	330,941	402,398	541,573	590,053	650,192
South Korea	56,177	66,004	69,885	79,768	92,905	96,487	116,248	138,475	153,162	160,954	177,614	191,979	203,919	220,871	240,551	264,786
Taiwan	71,000	74,776	75,383	83,700	97,038	104,372	128,187	139,648	152,272	152,585	149,580	159,417	158,268	167,748	173,906	186,186
Singapore Hong Kong	13,158 19,404	15,048 23,400	14,732 21,411	15,201 27,058	17,375 27,864	16,696 24,962	19,175 31,356	24,209 36,428	30,229 37,173	28,545 34,477	30,165 32,188	32,001 30,364	33,044 28,728	36,695 28,230	40,449 28,229	44,775 29,812
Exports																
All countries ^a	1,442,807	1,583,926	1,571,788	1,591,194	1,741,579	1,828,029	1,901,237	2,005,552	2,310,416	2,482,678	2,566,262	2,738,487	2,927,673	3,118,098	3,409,123	3,714,972
United States	205,076	215,057	196,520	180,829	190,702	190,464	200,625	223,520	264,049	305,129	325,537	348,973	375,126	377,147	416,582	467,518
Canada	44,565	50,655	51,778	55,429	66,920	70,194	77,883	76,625	86,283	83,531	87,029	88,615	97,605	105,809	122,345	138,911
Japan	167,319	193,214	193,229	200,055	228,986	240,658	239,059	236,189	256,177	271,250	282,871	286,565	289,159	278,073	278,147	294,184
Germany ^b	201,714	236,978	247,717	242,019	263,450	285,055	279,874	283,854	322,975	344,675	338,540	354,008	357,603	351,484	386,804	412,372
France	102,074	115,528	113,789	114,475	123,326	127,871	125,219	129,568	149,018	159,338	163,496	176,072	184,356	191,650	203,617	217,441
United Kingdom	97,352	92,825	93,078	91,172	98,780	105,171	116,086	121,666	144,213	146,143	153,904	167,575	168,925	174,021	179,349	195,422
Italy	82,515	94,925	95,392	96,995	103,152	112,328	111,828	112,926	127,040	136,181	133,165	136,445	141,531	164,161	176,868	191,834
China	14,390	16,860	16,614	16,623	18,414	15,966	20,939	25,122	38,878	38,979	54,583	63,869	77,492	87,194	107,234	119,935
South Korea	17,633	23,296	25,485	27,608	33,474	34,534	39,268	48,513	59,811	62,943	60,612	968,99	69,541	75,207	83,946	93,778
Taiwan	20,286	22,452	22,073	23,829	28,506	29,328	41,132	56,755	67,491	75,355	76,088	84,905	96,163	100,720	107,293	117,964
Singapore	11,180	12,492	13,177	14,857	17,006	16,498	21,250	25,985	36,375	42,896	45,966	52,626	58,917	69,654	84,947	96,015
Hong Kong	19,453	23,207	23,216	25,108	30,337	31,591	36,790	47,886	62,022	68,659	74,901	86,608	103,239	115,988	124,885	135,950
Imports																
All countries ^a	1,355,470	1,465,746	1,457,058	1,499,989	1,656,996	1,736,679	1,822,093	1,931,793	2,235,044	2,404,720	2,495,021	2,648,558	2,828,165	2,992,882	3,291,253	3,585,730
United States	173,649	204,481	210,587	250,310	324,929	353,212	366,596	365,466	384,887	406,655	396,489	387,994	435,854	489,119	537,703	5/6,158
Canada	51,245	58,682	50,260	57,261	68,601	71,350	72,911	78,075	90,093	98,754	99,412	100,695	101,563	108,776	123,213	133,322
Japan	47,230	20,930	100,371	22,093	1444	09,420	70,600	07,045	113,298	010,121	134,080	139,203	140,017	152,200	1/4,/14	197,470
France	98,668	104,291	109,703	104,221	107,032	113.643	124.751	135,868	160.660	173.266	180,143	186.363	188,200	186.337	201,043	216.062
United Kinadom	96,239	99,963	101,659	108.492	116.296	121,566	123,549	133.840	168.970	172,383	169.094	163,460	170.521	180.254	191,518	202,162
Italy	66,758	65,862	65,581	64,155	71,448	77,953	83,583	95,307	109,066	118,417	123,532	128,218	132,604	118,890	128,266	139,186
China	14,289	14,604	13,657	16,984	27,482	44,783	40,395	38,940	52,564	53,141	51,077	62,607	80,836	115,361	124,715	137,863
South Korea	13,022	14,866	15,222	17,648	21,232	21,472	24,892	30,324	36,218	41,572	45,731	52,718	49,631	52,659	64,567	76,666
Taiwan	13,436	14,463	13,377	14,835	17,295	16,200	19,659	26,525	34,951	39,898	40,662	46,822	54,346	56,858	60,356	66,577
Singapore	17,715	19,565	21,087	21,974	22,851	21,341	22,172	26,592	33,912	39,341	45,575	51,359	26,768	969,99	77,497	86,354
Hong Kong	22,741	25,879	25,275	26,029	30,677	29,929	32,900	40,676	56,456	56,355	69,827	83,032	99,873	96,913	111,483	122,135

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Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

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8.4.106.708 55556.80 2.164.566 1.054.569 572.208 1.208.203.40 2.173.61 2.775.528 1.245.569 1.241.140 5.164.158 1.245.140 2.755.41 2.255.58 1.245.56 1.245.78 2.255.78 1.245.78 2.255.78 2.255.78 1.245.78 2.255.78	8.417.02 2.78.48 9.38.38.00 9.73.281 2.68.291 2.68.236 2.77.575	_															
2106.292 252.516.082 216.516.092 226.516.092 226.226.093 226	2.105,765 2.205,666 2.156,867 2.175,744 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,882 2.823,382 2.823,382 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.823,881 2.828,882 2.828,811 2.828,881 2.828,881 2.828,881 2.828,881 2.828,881 2.828,881 2.828,881 2.828,881 2.828,881 2.828,881 <t< td=""><td>:</td><td></td><td></td><td></td><td>9,393,800</td><td>9,572,261</td><td></td><td>10,146,039</td><td></td><td></td><td>11,427,213</td><td>11,549,155</td><td></td><td>11,684,724</td><td></td><td>12,804,129</td></t<>	:				9,393,800	9,572,261		10,146,039			11,427,213	11,549,155		11,684,724		12,804,129
1917.659 1.002.20 1.446.51 1.505.30 1.011.62 1.22.51 2.02.52 1.25.10 1	1316.556 1400.422 1464.516 1500.326 1561.44 1461.672 1562.72.71 1669.374 131.585 141.16 1461.672 1562.72 1562.72.71 1669.374 131.585 141.16 1461.672 1562.72 1562.72.71 1669.374 131.585 141.16 1461.672 1562.72 1562.72.71 1669.374 131.585 141.16 1461.672 1562.72 156			. 4		2,523,681	2,508,602		2,682,354			2,725,599	2,643,581	2,811,863	2,927,328		3,220,240
1,316,529 1,024,72 1,024,72 1,024,74	1875 1875				•	226,800	240,892	245,133	258,238	273,305	279,780	264,567	252,267	252,572	272,835	289,283	300,078
862,748 8175 606,017 501,028 71,228 11 22,284 517,028 61,017,018 11,017,18 11,017,018 11,017,018 11,017,018 11,017,018 11,017,018 11,01	662,749 6881,75 690,524 715,405 722,801 722,804 631,883 542,524 780,00 614,728 780,728 780,00 614,728 780,00 61			_	_	1,611,164	1,681,672	1,637,217	1,669,374	1,831,589	1,971,387	2,124,376	2,254,859	2,163,972	2,039,724	2,087,976	2,182,756
450.04 4.82 56.06 5.02 4.92 5.02 4.92 5.02 4.92 5.02 4.92 5.02 5.02 4.92 5.02 5.02 4.92 6.02 5.02 4.92 6.02 5.02 4.92 6.02 5.02 4.92 6.02 5.02 4.92 6.02 5.02 4.92 6.02 5.02 4.92 6.02 5.02 4.92 6.02 5.02 5.02 5.02 5.02 5.02 5.02 5.02 5	. 460,044 482,2885 506,077 500,939 513,281 52,284 551,838 542,524 578,030 614,728 318,982 320,178 311,857 323,864 355,092 350,927 352,902 371,126 396,899 410,847 226,51 24,180 24,819 24,185 26,4185 24,180 24,181 129,711 129,711 144,767 146,201 144,767 146,201 177,71 121,311 129,711 144,767 146,201 146,803 146					752,801	796,702	815,768	823,871	857,135	914,116	985,762	1,073,180	1,049,783	1,081,847	1,155,929	1,205,635
377,831 374,847 381,387 402288 355,092 360,407 361,717 3 361,714 366,780 5 561,780 5 361,714 366,780 5 361,914 366,780 5 361,914 366,780 5 361,914 366,780 5 361,914 366,780 5 361,914 366,780 5 361,914 366,780 5 361,914 361,016 361,910 5 361,914 361,910 5 361,914 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914 361,910 5 361,914	317.831 374,487 381,387 402,2928 455,022 550,027 382,902 371,150 965,709 19164 318.802 320,178 32,386 324,86 35,759 281,379 32,902 371,150 396,909 140,877 36.202 63,703 66,428 77,074 29,44 55,029 291,971 31,311 129,701 144,777 145,201 291,603 291,103 24,130 24,130 24,131 29,701 129,701 144,777 145,201 291,603 24,190 24,190 24,178 26,025 10,771 121,311 129,701 144,777 145,201 291,603 24,190 24,178 26,025 10,771 121,311 129,701 144,777 145,201 291,603 24,190 24,178 26,025 10,771 121,311 129,701 144,777 145,201 32,646 32,175 36,103 30,460 24,190 30,460					513,261	522,694	531,883	542,524	578,030	614,728	630,507	631,857	625,556	582,411	609,991	629,634
Secondary String	318,982 230,178 24,128 24,146 255,768 281,979 274,544 294,317 294,082 40,0847 40,085 26,204 24,778 284,778 28,241 24,778 28,242 274,544 23,778 14,787 14,787 14,201 24,778 28,241 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 22,418 24,778 28,242 24,187 24,180 24,778 28,242 24,180 24,788 24,180 24,788 24,180 24,788 24,180 24,788 24,180 24,180 24,788 24,180					436,728	450,408	442,718	471,733	506,780	519,154	506,901	456,866	487,201	491,016	520,766	538,791
256,254 244,254 244,756 244,66 22,416 24,324 24,456	265.251 244.231 237,568 254,165 287,759 281,979 274,544 294,317 364,068 408,082 7,07,86 44,133 46,079 82,778 24,286 23,645 29,161 33,738 146,083 166,065 27,721 32,082 29,514 34,537 36,163 37,154 41,834 48,680 32,175 27,721 32,082 29,514 34,537 36,163 37,154 41,834 48,264 42,738 21,539 24,180 24,778 24,286 24,286 23,642 37,154 41,874 42,738 21,539 23,643 37,154 41,884 48,264 42,738 16,604 21,529 23,656 19,788 11,102 37,144 42,738 16,604 42,738 16,604 42,738 16,604 42,738 16,604 42,738 16,604 42,738 16,604 42,738 16,604 42,738 16,604 42,738 16,604 42,738 16,604					355,092	350,927	352,902	371,126	396,969	410,847	408,079	405,491	400,675	364,914	373,110	385,967
56,280 7,078 66,280 7,070 88,479 92,611 112,778 146,200 172,356 153,178 146,083 158,200 173,278 146,080 172,350 153,140 147,771 183,748 48,280 153,178 146,080 173,256 153,140 147,771 183,146 48,278 152,077 183,146 46,278 173,680 153,178 47,789 46,278 47,789 46,279 46,279 46,279 46,278	66,204 63,763 77,074 89,479 92,618 11,311 123,738 146,083 156,805 70,785 74,193 74,079 24,076 92,614 92,694 92,696 10,177 12,311 129,701 144,077 145,201 21,521 24,108 24,819 24,778 26,045 31,610 37,154 41,834 48,264 42,738 27,721 22,022 29,514 34,537 36,153 31,610 37,154 41,834 48,264 42,738 21,629 23,153 24,862 264,003 304,695 311,136 32,096 301,400 325,244 42,738 140,544 162,816 16,788 30,798 311,108 110,771 110,400 32,524 42,738 47,382 22,888 56,086 20,714 37,722 324,975 214,089 15,694 42,738 47,382 22,888 56,086 30,744 37,722 324,628 32,474 37,744 37,748 <td< td=""><td></td><td></td><td></td><td></td><td>257,759</td><td>281,979</td><td>274,544</td><td>294,317</td><td>364,063</td><td>409,692</td><td>325,969</td><td>348,929</td><td>430,243</td><td>597,814</td><td>637,164</td><td>691,281</td></td<>					257,759	281,979	274,544	294,317	364,063	409,692	325,969	348,929	430,243	597,814	637,164	691,281
This control This	1,0,78 74,183 74,079 82,941 95,695 101,771 121,311 129,701 144,767 145,201 145,201 121,331 24,180 24,819 24,778 26,042 24,286 23,645 29,614 32,082 29,514 34,537 36,153 31,610 37,154 41,834 48,264 42,738 31,610 32,032 31,610 32,032 31,610 32,148 32,178 31,610 32,148 32,248 31,610 32,148 31,614 31,624 32,572 31,333 31,244 32,572 35,228 40,488 43,895 45,864 46,895 44,027 44,027 45,686 51,626 51,					89,479	92,618	112,718	133,738	146,083	156,805	179,355	193,297	199,274	214,988	239,496	264,353
This can be a control of the contr	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,					95,695	101,771	121,311	129,701	144,767	145,201	142,585	153,140	153,145	162,367	167,531	178,265
Fig. 10.00 Fig. 10.00 Fig. 10.0 Fig. 10.0 Fig. 10.00 Fig.	High-tech industries					26,042	24,286	23,645	29,161	33,854	32,175	37,478	39,562	40,786	45,422	47,273	51,594
High-tech industries* 16.290 231.553 248.682 264.003 304.695 311,135 320,961 307,140 325,241 327,793 338,027 341,448 383,270 360,016 1.002,46 1.196,162 1.26,290 231,553 248,682 264,003 304,695 311,135 320,961 1.102 33.899 22.944 37722 34,893 328,027 341,448 383,270 360,016 1.102,20 23.899 22.944 23.772 34,448 363,270 341,448 383,270 360,016 1.102,20 33.899 32.944 37722 34,248 224,575 247,099 1.5,894 1.102 33.899 32.944 37722 34,248 37722 39,249 37,749 37,749	High-tech industries High-tech High-te					36,153	31,610	37,154	41,834	48,264	42,738	47,983	51,656	54,005	48,229	53,933	56,504
561 039 641,913 678,200 729,533 842,787 874,602 907,164 935,213 1,017,422 1,146,406 1,193,049 1,200,246 1,165,123 1,146,406 1,193,049 1,200,246 1,166,212 1,300,40 355,817 36,148 96,327 36,016 1,01,000 355,817 36,148 97,300 1,01,000 1,102 1,103 <t< td=""><td>591,039 641,913 678,200 729,533 842,787 874,602 907,164 933,213 1,041,079 1,107,432 1,733 216,290 231,563 246,602 264,003 304,695 311,135 320,961 301,400 325,241 327,733 37,733 37,732 1,041,079 1,107,432 1,1087 320,241 327,733 37,732 36,008 62,082 68,079 66,461 65,822 64,024 67,679 75,599 26,589 31,244 327,733 31,393 31,244 32,528 40,488 43,895 40,248 40,246 65,822 64,024 67,679 75,599 26,599 26,402 66,461 65,822 64,024 67,679 75,599 26,599 28,599 40,488 43,899 37,722 37,474 37,132 39,629 44,027 48,399 40,678 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 44,632 44,489 44,8</td><td></td><td></td><td></td><td></td><td></td><td>_</td><td>ligh-tech i</td><td>ndustries</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	591,039 641,913 678,200 729,533 842,787 874,602 907,164 933,213 1,041,079 1,107,432 1,733 216,290 231,563 246,602 264,003 304,695 311,135 320,961 301,400 325,241 327,733 37,733 37,732 1,041,079 1,107,432 1,1087 320,241 327,733 37,732 36,008 62,082 68,079 66,461 65,822 64,024 67,679 75,599 26,589 31,244 327,733 31,393 31,244 32,528 40,488 43,895 40,248 40,246 65,822 64,024 67,679 75,599 26,599 26,402 66,461 65,822 64,024 67,679 75,599 26,599 28,599 40,488 43,899 37,722 37,474 37,132 39,629 44,027 48,399 40,678 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 43,899 44,632 44,489 44,8						_	ligh-tech i	ndustries								
591,039 641,913 678,200 729,533 942,787 874,602 907,164 933,213 1,107,432 1,146,486 1,107,432 1,146,486 1,107,432 1,146,486 1,107,432 1,146,486 1,107,432 1,146,486 1,107,483 1,107,432 1,144,488 1,107,481 1,107,481 1,107,482 1,148 1,107,481 1,107,482 1,107 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482 1,107,482	591,039 641,913 678,200 729,533 942,787 874,602 907,164 933,213 1,014,079 1,107,432 1,17,432 1,17,432 1,17,432 1,17,432 1,107,432 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,433 1,17,444	luction															
216,290 231,553 248,692 264,003 304,995 311,135 320,961 301,400 325,241 327,789 388,027 314,448 363,270 350,016 350,016 360,016 <t< td=""><td>216,290 231,553 248,692 264,003 304,695 311,135 320,961 301,400 325,241 327,793 7,759 8,545 8,077 8,048 9,798 11,080 11,922 13,489 15,031 15,804 140,544 162,815 17,5356 19,578 226,617 6,441 65,832 64,024 67,762 64,413 65,822 64,024 67,839 31,087 36,228 40,884 43,896 43,896 56,258 40,884 43,896 44,027 48,896 43,896 56,258 40,488 43,896 44,027 48,896 45,816 49,984 54,628 58,258 40,896 43,896 44,88 43,896 44,897 44,88 43,896 44,88 43,896 44,88 43,896 44,88 43,896 44,88 43,896 44,88 43,896 44,88 44,896 14,896 11,843 14,88 14,890 14,890 14,890 14,890 14,890 14,890 14,890 14,890</td><td></td><td></td><td></td><td></td><td>842 787</td><td>874 602</td><td>907 164</td><td>933.213</td><td>1 041 079</td><td>1 107 432</td><td>1 146 496</td><td>1 193 049</td><td>1 200 246</td><td>1 196 162</td><td>1.305.495</td><td>1 401 256</td></t<>	216,290 231,553 248,692 264,003 304,695 311,135 320,961 301,400 325,241 327,793 7,759 8,545 8,077 8,048 9,798 11,080 11,922 13,489 15,031 15,804 140,544 162,815 17,5356 19,578 226,617 6,441 65,832 64,024 67,762 64,413 65,822 64,024 67,839 31,087 36,228 40,884 43,896 43,896 56,258 40,884 43,896 44,027 48,896 43,896 56,258 40,488 43,896 44,027 48,896 45,816 49,984 54,628 58,258 40,896 43,896 44,88 43,896 44,897 44,88 43,896 44,88 43,896 44,88 43,896 44,88 43,896 44,88 43,896 44,88 43,896 44,88 44,896 14,896 11,843 14,88 14,890 14,890 14,890 14,890 14,890 14,890 14,890 14,890					842 787	874 602	907 164	933.213	1 041 079	1 107 432	1 146 496	1 193 049	1 200 246	1 196 162	1.305.495	1 401 256
7,529 8,545 8,046 9,798 11,080	7,782 8,545 2,040 0,400 0,400 1,929 0,400 0,400 1,929 0,400 0,400 1,929 0,400 1,929 0,400 1,929 0,400 1,929 0,400 1,929 0,400 1,920 0,400 1,920 0,400 1,920 0,400 1,920 0,400 1,920 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 0,400 1,400 1,900 0,400 <th< td=""><td></td><td></td><td></td><td></td><td>304 605</td><td>311 135</td><td>320 061</td><td>301 400</td><td>305 041</td><td>207,101,</td><td>338 037</td><td>3/1 //8</td><td>363 270</td><td>350.016</td><td>307 207</td><td>777 713</td></th<>					304 605	311 135	320 061	301 400	305 041	207,101,	338 037	3/1 //8	363 270	350.016	307 207	777 713
140,544 16,284 17,536 17,536 17,536 17,536 17,537 17,538 17,538 17,538 17,538 17,538 17,538 17,538 17,538 17,538 17,539	14,736 52,835 56,006 62,026 68,079 66,461 65,834 234,572 247,089 71,020 71,00		Ú			004,093	11,133	11 022	12 489	15,024	15 904	16.067	041,140	10,250	17.746	391,297	21,444
1,000 1,000 1,000 1,000 1,000 1,000 201,100 202,24 1,100 202,100 201,100 202,100 201,100 202,100 201,100 202,100 201,100 202,100 201,100 202,100 201,100 202,100 201,100 202,100 201,100 202,200 31,102 37,474 37,132 39,629 40,676 40,000 50,140 50,140 50,140 50,140 50,140 50,140 50,140 50,140 50,140 50,140 51,125 51,125 51,125 51,125 51,125 51,125 51,125 51,125 51,125 51,126 61,126	140,044 160,044 160,044 160,044 160,044 160,044 160,044 160,044 160,044 160,042 160,047 160,041 160,042 160,047 160,041 160,042 160,074 <t< td=""><td></td><td></td><td></td><td></td><td>9,790</td><td>1,000</td><td>226,11</td><td>04,7</td><td>13,03</td><td>1,000</td><td>10,200</td><td>0.1,10</td><td>20,000</td><td>7,7,40</td><td>710,020</td><td>077,12</td></t<>					9,790	1,000	226,11	04,7	13,03	1,000	10,200	0.1,10	20,000	7,7,40	710,020	077,12
2. 68.0 3.0,000 22,002 3.0,000 3.2,002 3.0,000 <th< td=""><td>47,302 30,106 62,002 06,079 07,471 07,424 07,472 07,474 07,424 07,474 07,473 07,673 07,679 07,679 07,679 07,679 07,679 07,679 07,679 07,679 07,679 07,674 07,772 07,474 07,722 07,474 07,722 07,479 07,476 07,466 07,676 07,467 07,676 07,467 07,676 07,467 07,476 07,467 07,477 07,676 07,477 07,476 07,676 07,477 07,477 07,676 07,477 07,477 07,676 07,477<</td><td></td><td></td><td></td><td></td><td>710,022</td><td>750,044</td><td>24,070</td><td>247,069</td><td>203,274</td><td>311,007</td><td>902,719</td><td>301,320</td><td>332,300</td><td>307,732</td><td>320,324</td><td>320,202</td></th<>	47,302 30,106 62,002 06,079 07,471 07,424 07,472 07,474 07,424 07,474 07,473 07,673 07,679 07,679 07,679 07,679 07,679 07,679 07,679 07,679 07,679 07,674 07,772 07,474 07,722 07,474 07,722 07,479 07,476 07,466 07,676 07,467 07,676 07,467 07,676 07,467 07,476 07,467 07,477 07,676 07,477 07,476 07,676 07,477 07,477 07,676 07,477 07,477 07,676 07,477<					710,022	750,044	24,070	247,069	203,274	311,007	902,719	301,320	332,300	307,732	320,324	320,202
26,839 31,102 33,889 32,944 37,722 37,474 37,122 37,424 37,122 37,424 37,122 37,424 37,122 37,424 37,122 37,424 37,122 37,424 37,122 37,424 37,122 37,424 37,122 37,424 37,124 37,124 37,124 37,124 37,124 37,124 37,124 37,124 37,124 37,124 37,124 37,122 37,124 37,125 37,127 37,125 37,127<	26,839 31,244 37,722 37,474 37,132 39,629 44,027 48,339 31,333 31,244 32,572 35,228 40,488 43,895 45,816 49,984 54,628 58,255 15,910 16,244 14,622 35,233 15,244 24,628 58,255 58,255 40,488 45,816 16,210 19,050 20,533 15,245 26,813 9,253 9,399 13,326 17,568 21,245 21,526 20,533 21,245 21,526 21,526 25,423 10,437 10,959 14,686 11,843 21,246 21,526 21,526 21,245 5,432 7,437 10,959 14,686 11,843 21,246 21,526 21,526 21,527 21,526 21,526 21,527 21,526 21,527 21,528 21,486 11,843 21,528 21,486 11,843 21,528 21,486 11,843 21,528 21,488 31,548 21,538 21,486 11,484 21,538 21,548 <					68,078	66,461	65,832	64,024	6/9//9	75,599	80,798	89,459	85,107	92,529	/91,101	106,078
31,333 31,244 32,572 36,228 40,488 43,886 45,816 49,984 54,628 58,255 59,284 56,133 57,843 56,106 15,910 15,284 14,633 15,244 14,600 15,406 15,286 19,289 20,706 19,289 18,349 14,107 14,107 14,988 5,156 6,813 9,253 9,339 13,326 17,568 21,245 21,526 24,172 24,895 25,496 29,781 16,6115 26,115 16,115 17,667 17,248 17,676 17,676 19,289 17,127 24,895 25,496 29,781 17,678 21,245 21,526 21,477 24,472 24,472 17,678 21,245 21,526 21,477 24,476 16,5116 17,678 17,478 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678 17,678	31.393 31.244 22.572 35.228 40,488 43.895 45.816 49.984 54.628 58.256 15,910 15,264 14,633 15,822 16,217 14,600 15,406 16,510 19,050 20,533 11,609 10,146 10,072 12,781 15,434 24,632 23,939 28,667 38,912 21,246 21,526 20,533 2,410 4,968 5,125 6,813 9,251 10,437 15,697 19,238 21,245 21,526 2,616 2,839 2,748 3,762 5,354 5,437 10,359 14,868 21,486 11,843 2,616 2,839 2,748 3,670 3,927 2,833 3,856 11,843 21,245 21,267 3,194 2,333 3,138 2,949 3,670 3,927 2,833 3,856 5,127 5,724 5,019 2,439 33,139 36,074 40,678 43,934 47,384 51,396					37,722	37,474	37,132	39,629	44,027	48,399	50,140	54,040	52,605	51,125	53,478	56,041
15,910 15,264 14,663 15,824 16,510 16,510 19,050 20,766 19,289 18,346 16,925 1,1609 10,146 10,146 16,510 19,060 20,569 23,939 28,567 24,383 22,77 24,885 25,946 97,811 4,107 4,686 5,168 6,020 7,626 9,921 10,437 15,897 12,387 22,497 25,268 25,946 31,117 2,646 2,839 6,020 7,626 9,921 10,437 16,897 12,387 22,797 23,497 25,268 25,946 31,117 2,616 2,839 6,020 7,626 9,921 10,437 10,959 14,866 11,843 12,946 13,501 14,705 17,567 2,616 2,839 5,772 5,724 6,019 4,761 4,706 17,567 4,076 4,076 4,943 5,370 5,899 6,274 6,019 4,761 4,761 4,766 1,476	15,910 15,264 14,633 15,822 16,217 14,600 16,406 16,510 19,050 20,593 11,609 10,146 10,072 12,781 15,344 24,622 23,939 28,567 38,912 43,833 4,107 4,958 5,155 6,813 9,253 9,399 13,326 17,568 21,245 21,526 2,616 2,889 6,020 7,626 9,921 10,437 16,897 19,238 21,880 22,797 2,616 2,889 6,020 7,626 9,921 10,437 16,897 19,238 21,880 11,843 2,616 2,889 6,000 3,670 3,927 2,833 3,856 5,127 5,724 5,019 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,22,26 27,805 28,588 35,077 46,277 47,963 50,388 52,243 67,584 14,433 <td></td> <td></td> <td></td> <td></td> <td>40,488</td> <td>43,895</td> <td>45,816</td> <td>49,984</td> <td>54,628</td> <td>58,255</td> <td>59,284</td> <td>56,133</td> <td>57,843</td> <td>56,106</td> <td>62,200</td> <td>66,811</td>					40,488	43,895	45,816	49,984	54,628	58,255	59,284	56,133	57,843	56,106	62,200	66,811
11,609 10,146 10,072 12,781 15,344 24,632 23,939 28,567 38,912 43,833 32,710 35,939 47,162 65,115 4,107 4,958 6,155 6,813 9,253 9,399 13,326 17,568 21,245 21,927 24,477 25,536 25,446 25,436 25,478 31,117 2,616 2,839 2,748 3,762 5,324 5,423 17,487 17,487 22,797 24,477 25,536 31,117 2,616 2,839 2,748 3,762 5,344 5,423 14,477 17,479 17,477 17,477 17,476 17,477 17,476 17,477 17,476 17,477 17,476 17,477 17,476 17,479 17,477 17,489 17,471 17,476 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479 17,479	11,609 10,146 10,072 12,781 15,344 24,632 23,939 28,567 38,912 43,833 4,107 4,988 5,155 6,813 9,253 9,339 13,326 17,568 21,245 21,256 2,616 2,839 6,020 7,626 9,921 10,437 16,938 14,686 11,843 2,616 2,839 6,020 7,626 9,921 10,437 16,938 14,686 11,843 2,616 2,839 6,278 5,432 7,437 10,959 14,686 11,843 2,616 2,839 3,670 3,927 2,833 3,856 5,127 5,724 5,019 2,701 3,670 3,927 47,384 51,599 59,628 71,978 80,349 2,701 3,40 3,816 3,928 4,943 5,370 5,899 6,274 6,784 7,976 2,701 3,61 3,677 46,277 47,963 50,388 52,243 <td< td=""><td></td><td></td><td></td><td></td><td>16,217</td><td>14,600</td><td>15,406</td><td>16,510</td><td>19,050</td><td>20,593</td><td>20,766</td><td>19,289</td><td>18,346</td><td>16,925</td><td>17,673</td><td>18,806</td></td<>					16,217	14,600	15,406	16,510	19,050	20,593	20,766	19,289	18,346	16,925	17,673	18,806
4,107 4,968 5,155 6,813 9,253 9,399 13,236 17,568 21,245 21,526 24,172 24,895 25,5946 29,781 2,423 5,889 6,020 7,626 9,921 10,437 15,697 19,238 21,286 22,797 22,787 25,586 25,665 31,177 2,616 2,889 6,020 7,626 9,921 10,437 15,687 11,843 12,946 13,501 14,767 17,567 2,333 3,138 2,949 3,670 2,943 272,562 322,394 375,482 45,188 4,761 4,784 4,767 136,339 158,619 164,430 181,571 215,190 229,221 24,438 272,562 332,340 37,488 4,761	4,107 4,958 5,155 6,813 9,253 9,399 13,326 17,568 21,245 21,526 2,423 5,889 6,020 7,626 9,921 10,437 16,697 19,238 21,880 22,797 2,516 2,839 6,020 7,626 9,921 10,437 16,939 14,686 11,843 2,533 3,138 2,949 3,670 3,927 2,833 3,856 5,127 5,724 5,019 2,701 36,439 36,774 40,678 47,384 51,599 59,628 71,978 80,340 2,701 3,460 3,816 3,816 47,384 51,599 52,74 5,019 2,701 3,460 3,816 3,816 47,384 51,599 52,24 5,019 2,701 3,460 3,816 4,277 47,968 50,338 52,24 5,019 2,703 2,818 35,077 46,277 47,968 50,388 52,24 50,49				•	15,344	24,632	23,939	28,567	38,912	43,833	32,710	35,939	47,162	65,115	71,375	81,341
5,423 5,889 6,020 7,626 9,921 10,437 15,697 19,238 21,880 22,797 23,497 25,258 25,655 31,117 2,616 2,839 2,748 3,762 5,354 5,422 7,437 10,959 14,886 11,843 12,946 13,501 14,705 17,567 2,333 3,138 2,949 3,670 2,927 2,438 37,243 4,761 4,192 4,761 4,192 4,766 17,567 3,439 36,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 40,767 4,761 4,7384 47,384 51,298 52,243 6,788 72,48 6,788 72,439 6,788 72,439 6,788 72,49 6,788 72,43 6,788 72,43 6,788 72,49 6,788 72,49 6,788 72,49 72,69 6,788 72,445 32,445 33,49 32,459 32,445 33,49 32,459	5,423 5,889 6,020 7,626 9,921 10,437 15,697 19,238 21,880 22,797 2,616 2,839 6,020 7,626 9,921 10,437 16,697 19,238 21,880 22,797 2,616 2,839 2,748 3,762 5,354 5,422 7,437 10,959 14,686 11,843 136,339 158,619 164,430 181,571 215,190 229,221 245,438 572,562 332,394 375,482 2,701 3,460 3,816 3,928 43,934 47,384 51,599 62,270 67,88 7,276 22,258 2,780 3,816 3,928 4,937 47,394 51,599 62,274 67,88 7,766 22,258 2,780 3,816 3,507 46,937 47,394 51,399 62,243 67,88 7,766 2,789 2,780 2,816 2,196 26,494 23,678 24,426 29,445 36,49 7,09						6,399	13,326	17,568	21,245	21,526	24,172	24,895	25,946	29,781	34,913	39,632
2,616 2,839 2,748 3,762 5,354 5,422 7,437 10,959 14,886 11,843 12,946 13,501 14,705 17,567 2,333 3,138 2,949 3,670 3,927 2,833 3,856 5,127 5,724 5,019 4,761 4,192 4,288 4,076 136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 403,546 451,551 487,091 523,124 5 2,701 3,607 40,678 43,934 47,384 51,599 59,628 71,978 80,340 90,147 97,333 105,134 102,639 10,409 2,701 3,607 40,678 43,934 47,384 51,599 59,628 71,978 80,340 90,147 97,333 105,134 102,639 10,409 2,701 3,609 46,677 40,277 41,988 50,228 71,978 80,340 37,419 37,419 <t< td=""><td>2,616 2,839 2,748 3,762 5,354 5,432 7,437 10,959 14,686 11,843 2,333 3,138 2,949 3,670 3,927 2,833 3,866 5,127 5,724 5,019 136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 5,019 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 14,137 13,651 15,069 10,728 12,907 13,207 12,829 17,671 20,586 14,143 13,651 15,069 16,072 18,450 20,482 23,442 29,445 33,649 14,</td><td></td><td></td><td></td><td></td><td></td><td>10,437</td><td>15,697</td><td>19,238</td><td>21,880</td><td>22,797</td><td>23,497</td><td>25,258</td><td>25,655</td><td>31,117</td><td>29,779</td><td>33,325</td></t<>	2,616 2,839 2,748 3,762 5,354 5,432 7,437 10,959 14,686 11,843 2,333 3,138 2,949 3,670 3,927 2,833 3,866 5,127 5,724 5,019 136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 5,019 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 14,137 13,651 15,069 10,728 12,907 13,207 12,829 17,671 20,586 14,143 13,651 15,069 16,072 18,450 20,482 23,442 29,445 33,649 14,						10,437	15,697	19,238	21,880	22,797	23,497	25,258	25,655	31,117	29,779	33,325
2,333 3,138 2,949 3,670 3,927 2,833 3,856 5,127 5,724 5,019 4,761 4,192 4,288 4,076 136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 403,546 451,551 487,091 523,124 5 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 8,566 10,005 10,687 10,409 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 8,566 10,005 10,409 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,419 10,409 7,276 8,566 10,005 10,409 7,659 10,409 7,419 7,419 7,419 7,419 7,419 7,419 7,419 7,419 7,419 7,419 7,419	2,333 3,138 2,949 3,670 3,927 2,833 3,856 5,127 5,724 5,019 136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 4,019 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,703 20,405 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 14,143 13,651 16,072 10,289 17,671 17,667 20,686 14,144 13,651						5,432	7,437	10,959	14,686	11,843	12,946	13,501	14,705	17,567	20,459	23,410
136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 403,546 451,551 487,091 523,124 5 35,439 36,734 40,678 47,384 51,599 59,628 71,978 80,340 90,147 97,933 105,134 102,639 10,005 10,005 10,409 10,409 10,409 10,409 10,409 10,409 10,687 10,409 10,409 10,409 10,409 10,409 10,409 10,409 10,687 10,409 1	136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 275,482 273,040 392,834 47,384 51,599 59,628 71,978 80,340 27,076 27,071 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 80,340 7,276 22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 7,276 67,584 7,276 67,584 7,276 67,584 7,276 67,584 7,276 67,584 7,276 7,277 47,963 50,338 52,243 62,270 67,584 7,276 67,584 7,276 67,584 7,276 67,584 7,276 17,677 17,677 17,677 17,677 17,677 17,677 17,677 17,489 17,677 17,489 17,677 17,489 17,677 17,109 17,489 17,677 17,109 17,486 17,677 17,109						2,833	3,856	5,127	5,724	5,019	4,761	4,192	4,288	4,076	4,236	4,688
136,339 156,619 164,430 181,571 215,190 229,221 245,438 272,562 332,394 375,482 463,546 451,561 487,091 523,124 5 35,439 36,743 40,678 47,384 51,599 59,628 71,978 80,340 90,147 97,933 105,134 102,639 10,005 10,005 10,687 10,409 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6274 6,788 7,276 8,566 10,005 10,409 10,409 2,701 3,816 3,928 4,943 5,370 5,899 6274 6,788 7,276 8,566 10,005 10,409 10,409 2,704 2,806 20,388 52,243 62,270 67,586 20,496 37,419 37,614 28,196 1,4373 20,405 2,806 20,445 23,445 32,449 32,449 32,449 32,449 37,419 37,614 28,196 1,43	136,339 158,619 164,430 181,571 215,190 229,221 245,438 272,562 332,334 375,482 4 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 22,258 27,805 28,588 35,077 46,277 47,683 50,388 52,243 62,270 67,584 14,373 20,405 23,033 22,191 25,195 26,494 23,678 24,426 29,445 33,649 14,143 13,651 16,072 18,450 20,862 23,47 21,202 26,665 28,646 14,143 13,651 15,069 16,072 18,450 20,862 23,47 21,202 26,665 28,646 14,143 13,651 16,072 18,450 20,862 23,47 21,202 26,665 28,646	ırts															
35,439 36,074 40,678 43,934 47,384 51,599 59,628 71,978 80,340 90,147 97,933 105,134 102,639 105,134 102,639 105,178 10,005 10,687 10,409 102,639 105,748 7,276 8,566 10,005 10,687 10,409 10,409 10,409 10,409 10,409 10,409 10,409 10,409 10,409 10,687 10,409 10,409 10,687 10,409 10,409 10,687 10,409 10,409 10,672 10,409 10,409 10,677 4,982 26,446 23,644 32,449 32,	35,439 39,139 36,074 40,678 43,934 47,384 51,599 59,628 71,978 80,340 2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 14,373 20,405 23,033 22,191 25,195 26,499 23,678 24,426 29,445 33,649 14,143 13,651 16,072 12,907 13,207 12,829 17,719 17,657 20,862 23,447 21,202 26,665 28,646 4,355 5,171 5,729 6,795 8,141 7,639 7,614 9,453 10,489 1,878 2,280 2,283 4,17 1,486 6,780 9,445 1,710 1,878 2,280 2,248 3,149 4,104 4,417 6,169 9,446 1,700 2,554	·	'		·	215,190	229,221	245,438	272,562	332,394	375,482	403,546	451,551	487,091	523,124	598,881	670,822
2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 8,566 10,005 10,687 10,409 22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 71,102 74,094 74,862 72,528 14,373 20,405 23,033 22,191 25,195 26,494 23,678 24,426 29,445 33,649 32,459 74,19 74,194 37,611 14,143 15,651 16,096 16,772 18,450 20,862 23,747 21,202 26,665 28,646 30,464 38,745 36,443 39,926 14,143 13,651 16,772 18,450 20,862 23,747 21,202 26,665 28,646 30,464 38,745 36,443 39,926 4,355 5,171 5,799 6,799 8,141 7,639 7,614 22,669 21,38 4,789 17,701 14,607 16,74	2,701 3,460 3,816 3,928 4,943 5,370 5,899 6,274 6,788 7,276 22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 14,373 20,405 23,033 22,191 25,195 26,494 23,678 24,426 29,445 33,649 7,099 9,033 11,695 10,728 12,907 13,207 12,829 14,719 17,657 20,586 14,143 13,651 15,069 16,072 18,450 20,862 23,747 21,202 26,665 28,646 4,355 5,171 5,729 6,795 8,141 7,639 7,614 9,453 10,489 307 336 346 417 713 4,86 6,780 7,644 14,710 1,878 2,280 2,242 3,307 4,214 3,882 6,063 10,035 14,710 2,502 2,366 2,448					43,934	47,384	51,599	59,628	71,978	80,340	90,147	97,933	105,134	102,639	114,473	128,709
22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 71,102 74,094 74,862 72,528 14,373 20,405 23,033 22,191 25,195 26,494 23,678 24,426 29,445 33,649 32,459 37,419 36,414 37,051 7,099 9,063 11,695 10,728 12,907 13,207 12,829 14,719 17,657 20,586 20,296 26,356 26,414 28,196 14,143 13,651 15,069 16,072 18,450 20,862 28,646 30,464 38,745 36,433 39,926 4,355 5,171 5,727 6,795 8,141 7,639 7,614 9,465 10,89 10,741 11,375 12,792 307 3,48 417 7,639 7,644 3,483 7,85 10,666 2,269 2,138 4,780 6,790 7,893 2,707 3,009 2,744 <	22,258 27,805 28,588 35,077 46,277 47,963 50,338 52,243 62,270 67,584 14,373 20,405 23,033 22,191 25,195 26,494 23,678 24,426 29,445 33,649 7,099 9,063 11,695 10,728 12,907 13,207 12,829 14,719 17,657 20,586 14,443 13,651 15,069 16,072 18,450 20,882 23,747 21,202 26,685 28,646 4,355 5,171 5,729 6,795 8,141 7,639 7,614 9,453 10,489 307 336 346 417 713 488 6,780 9,445 10,489 1,878 2,280 2,229 3,073 4,214 3,882 6,083 10,035 14,710 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,886 2,754 <td< td=""><td></td><td></td><td></td><td></td><td>4,943</td><td>5,370</td><td>5,899</td><td>6,274</td><td>6,788</td><td>7,276</td><td>8,566</td><td>10,005</td><td>10,687</td><td>10,409</td><td>12,591</td><td>14,890</td></td<>					4,943	5,370	5,899	6,274	6,788	7,276	8,566	10,005	10,687	10,409	12,591	14,890
14,373 20,405 23,033 22,191 25,195 26,494 23,678 24,426 29,445 33,649 32,459 37,419 36,414 37,051 7,099 9,063 11,695 10,728 12,907 13,207 12,829 14,719 17,657 20,586 20,296 25,356 26,414 28,196 14,143 13,651 15,069 16,072 18,450 20,862 23,747 21,202 26,665 28,646 30,464 38,745 36,443 39,926 4,355 5,171 5,727 5,799 6,795 8,141 7,639 7,614 9,453 10,489 10,689 10,741 11,375 12,792 307 336 347 413 483 785 1,066 2,269 2,138 4,139 4,780 6,790 7,629 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 14,607 16,799 17,016 19,6	14,373 20,405 23,033 22,191 25,195 26,494 23,678 24,426 29,445 33,649 7,099 9,063 11,695 10,728 12,907 13,207 12,829 14,719 17,657 20,586 14,143 13,651 15,069 16,072 18,450 20,862 23,747 21,202 26,665 28,446 307 336 346 417 7,639 7,614 9,453 10,489 1,878 2,280 3,773 4,311 4,86 6,780 9,445 12,967 14,710 2,707 3,099 2,744 3,073 4,114 4,486 6,083 10,035 15,824 2,502 2,286 2,428 3,149 4,104 4,417 6,169 9,146 14,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706				.,	46,277	47,963	50,338	52,243	62,270	67,584	71,102	74,094	74,862	72,528	74,568	79,652
7,099 9,063 11,695 10,728 12,807 13,207 12,829 14,719 17,657 20,586 20,296 25,356 26,414 28,196 14,143 13,651 15,069 16,072 18,450 20,862 23,747 21,202 26,665 28,646 30,464 38,745 36,443 39,926 4,355 5,171 5,727 5,799 6,795 8,141 7,639 7,614 9,453 10,489 10,689 10,741 11,375 12,792 307 336 346 417 713 483 785 1,066 2,269 2,138 4,139 4,780 6,790 7,629 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 14,607 16,798 17,016 19,670 28,694 26,072 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 17,016	7,099 9,063 11,695 10,728 12,907 13,207 12,829 14,719 17,657 20,586 14,143 13,651 15,069 16,072 18,450 20,862 23,747 21,202 26,665 28,646 4,355 5,171 5,729 6,795 8,141 7,639 7,614 9,453 10,489 307 336 346 417 713 483 785 1,066 2,269 2,138 1,878 2,280 3,073 4,311 4,486 6,780 9,445 12,967 14,710 2,502 2,724 3,073 4,104 4,117 6,169 9,146 14,782 15,824 2,502 2,286 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706					25,195	26,494	23,678	24,426	29,445	33,649	32,459	37,419	36,414	37,051	42,519	46,100
14,143 13,651 15,069 16,072 18,450 20,862 23,747 21,202 26,665 28,646 30,464 38,745 36,443 39,926 4,355 5,171 5,727 5,799 6,795 8,141 7,639 7,614 9,453 10,489 10,689 10,741 11,375 12,792 307 336 417 713 483 785 1,066 2,269 2,138 4,139 4,780 6,790 7,629 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 14,607 16,798 17,814 18,922 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 17,016 19,649 22,309 26,799 33,388 2,502 2,326 2,428 3,149 4,104 4,417 6,169 14,088 17,001 19,649 22,309 26,799 33,388	14,143 13,651 15,069 16,072 18,450 20,862 23,747 21,202 26,665 28,646 4,355 5,171 5,727 5,799 6,795 8,141 7,639 7,614 9,453 10,489 307 336 346 417 713 483 785 1,066 2,269 2,138 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706					12,907	13,207	12,829	14,719	17,657	20,586	20,296	25,356	26,414	28,196	30,200	32,907
4,355 5,171 5,727 5,799 6,795 8,141 7,639 7,614 9,453 10,489 10,689 10,741 11,375 12,792 307 336 346 417 713 483 785 1,066 2,269 2,138 4,139 4,780 6,790 7,629 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 14,607 16,798 17,814 18,922 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 17,016 19,670 23,664 26,072 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 19,649 22,309 26,799 33,388	4,355 5,171 5,727 5,799 6,795 8,141 7,639 7,614 9,453 10,489 307 336 346 417 713 483 785 1,066 2,269 2,138 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706		•			18,450	20,862	23,747	21,202	26,665	28,646	30,464	38,745	36,443	39,926	42,834	48,257
307 336 346 417 713 483 785 1,066 2,269 2,138 4,139 4,780 6,790 7,629 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 14,607 16,798 17,814 18,922 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 17,016 19,670 23,664 26,072 2,556 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 19,649 22,309 26,799 33,388	307 336 346 417 713 483 785 1,066 2,269 2,138 1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706					6,795	8,141	7,639	7,614	9,453	10,489	10,689	10,741	11,375	12,792	13,397	14,887
1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 14,607 16,798 17,814 18,922 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 17,016 19,670 23,664 26,072 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 19,649 22,309 26,799 33,388	1,878 2,280 2,229 3,073 4,311 4,486 6,780 9,445 12,967 14,710 2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706					713	483	785	1,066	2,269	2,138	4,139	4,780	6,790	7,629	10,458	12,173
2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 17,016 19,670 23,664 26,072 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 19,649 22,309 26,799 33,388	2,707 3,009 2,744 3,307 4,214 3,882 6,063 10,035 13,452 15,824 2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706					4,311	4,486	6,780	9,445	12,967	14,710	14,607	16,798	17,814	18,922	22,893	27,707
2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 19,649 22,309 26,799 33,388	2,502 2,356 2,428 3,149 4,104 4,417 6,169 9,146 14,088 17,001 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706					4,214	3,882	6,063	10,035	13,452	15,824	17,016	19,670	23,664	26,072	29,820	34,606
	2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706					4,104	4,417	6,169	9,146	14,088	17,001	19,649	22,309	26,799	33,388	45,047	51,963
. 2,554 2,988 2,754 3,627 5,061 4,745 5,132 7,173 10,660 11,706 13,366 15,036 17,696 20,667					3,627	5,061	4,745	5,132	7,173	10,660	11,706	13,366	15,036	17,696	20,667	24,888	28,111

Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Imports All countries ^a	121 045	143 141	147 261	165 042	199 632	212 984	230 269	256 721	319 690	361 256	389 724	431 156	466 251	499 417	575 783	645.356
United States	16,953	22.576	24.361	33,224	47,650	50.088	52.738	55,719	64.431	73,906	73,855	78,537	93,060	102,881	116,797	134.379
Canada	5,080	6,207	5,632	6,577	8,493	8,319	9,038	10,222	13,424	13,412	14,828	16,889	17,784	17,539	20,050	23,422
Japan	4,726	5,561	5,332	6,293	999'9	7,491	8,854	10,333	13,279	15,595	18,425	19,171	20,650	23,595	29,425	34,607
Germany ^b	11,513	13,716	13,939	15,326	16,573	18,385	21,101	23,721	27,498	31,511	38,628	42,703	43,018	42,171	47,692	53,577
France	8,254	11,672	13,924	12,206	13,925	14,222	14,319	16,184	22,725	25,967	26,873	32,247	29,542	29,074	31,681	34,978
United Kingdom	10,758	11,441	11,922	14,014	15,892	17,097	17,117	19,775	25,832	29,351	30,230	29,489	30,848	34,268	36,872	38,520
Italy	5,378	6,070	6,150	6,167	7,665	8,752	9,594	11,323	14,115	14,814	16,652	17,785	17,489	15,596	17,024	18,575
China	851	948	784	1,288	3,129	6,104	3,943	4,832	6,321	6,246	6,176	7,866	11,375	16,050	19,394	21,000
South Korea	1,737	1,933	2,041	2,924	3,718	3,558	4,337	5,303	7,577	8,102	8,652	10,142	10,357	10,858	12,987	15,611
Taiwan	1,791	2,080	2,310	2,507	3,135	2,947	3,925	5,403	7,048	8,411	9,078	10,845	12,892	13,932	15,170	16,916
Singapore	2,977	2,974	3,274	4,494	5,121	5,127	5,461	7,120	9,638	11,980	14,448	16,711	18,864	23,358	30,015	34,259
Hong Kong	2,658	2,850	2,785	3,457	4,924	4,457	4,809	6,487	9,891	866'6	12,743	15,512	19,500	19,444	23,111	26,298
Apparent consumption																
All countries ^a	619,157	677,833	714,695	772,608	897,756	933,984	971,482	1,005,470	1,134,762	1,214,277	1,262,325	1,318,735	1,340,470	1,346,029	1,481,316	1,605,229
United States	209,338	227,781	248,830	269,964	322,943	329,573	339,302	317,448	341,871	348,450	352,266	355,396	387,151	385,506	439,082	494,936
Canada	10,807	12,137	10,826	11,664	14,557	15,360	16,517	19,013	23,404	23,786	24,687	26,601	28,179	27,542	31,145	33,801
Japan	129,530	148,735	160,516	173,148	200,698	209,092	208,036	220,705	252,792	279,200	304,202	328,645	300,448	280,427	298,039	315,218
Germany ^b	50,890	55,443	57,412	65,193	70,756	70,210	73,702	74,125	78,818	88,512	101,405	111,403	107,906	114,507	125,682	133,236
France	29,931	36,187	39,333	37,370	42,295	42,134	42,170	45,175	54,000	59,513	62,380	68,015	63,125	59,915	63,439	66,944
United Kingdom	31,537	32,453	33,186	37,234	42,571	45,428	45,225	53,658	60,166	65,691	66,050	56,351	60,851	29,867	66,685	69,149
Italy	18,452	17,983	17,088	18,247	19,510	18,132	20,084	22,923	27,076	28,656	30,528	30,149	28,487	24,265	26,145	27,616
China	12,179	10,786	10,542	13,696	17,840	30,311	27,205	32,494	43,342	48,300	35,469	39,911	53,173	75,306	82,854	88,637
South Korea	4,409	5,146	5,423	7,353	9,646	9,670	12,821	15,931	19,389	19,016	22,251	22,822	23,375	26,961	31,022	35,016
Taiwan	4,789	5,291	5,803	7,249	809'6	10,298	15,192	18,115	20,587	21,915	23,192	25,644	26,323	31,403	29,315	32,163
Singapore	3,373	3,691	3,839	5,443	6,778	6,617	7,403	10,044	12,189	9,222	10,607	11,063	10,720	12,563	12,429	13,526
Hong Kong	2,933	3,585	3,514	4,290	4,920	3,586	4,659	6,081	7,299	2,800	7,028	7,854	9,979	7,178	7,882	8,629
							Aircraft	aft								

Production																
All countries ^a	111,561	118,741	121,166	122,112	132,880	143,729	153,164	159,360	170,150	178,634	179,623	181,645	181,957	166,030	181,099	179,616
United States	70,590	74,755	76,806	78,648	85,599	92,782	101,477	103,600	108,325	108,401	113,407	114,356	110,582	92,320	104,937	99,486
Canada	2,226	2,394	1,835	1,613	2,037	2,377	2,813	3,021	3,534	3,915	4,219	3,820	3,509	3,121	4,181	4,245
Japan	2,999	3,463	3,588	3,687	3,977	4,426	4,232	5,026	5,560	5,518	5,464	5,356	5,655	5,461	5,152	5,048
Germany ^b	4,276	4,817	4,734	4,647	4,704	5,473	5,253	6,104	6,318	8,484	8,951	8,946	7,566	7,638	7,430	7,805
France	7,267	9,162	10,410	9,098	10,665	9,243	7,953	8,318	9,814	11,101	10,378	12,122	10,371	9,062	8,614	8,648
United Kingdom	10,519	10,511	10,119	10,309	10,387	11,730	13,478	14,341	14,737	16,242	16,543	15,614	16,318	15,082	15,417	15,955
Italy	3,236	3,138	3,123	2,877	2,934	2,991	3,207	3,205	3,977	4,112	3,423	3,112	2,864	2,552	2,615	2,653
China	3,875	2,982	2,989	3,792	3,808	5,609	5,169	980'9	6,403	7,951	4,783	5,549	11,238	17,489	19,019	21,125
South Korea	-	2	2	2	ဇ	က	က	4	2	2	7	400	290	256	277	317
Taiwan	188	197	194	171	182	208	270	267	259	300	291	335	309	351	329	369
Singapore	92	100	131	173	201	282	306	324	372	297	334	337	454	463	485	539
Hong Kong	0	0	0	-	-	-	-	-	2	5	2	137	157	144	137	149

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Appendix table 6-5. Global industry and trade data, by selected countries and industries: 1980-95 (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Exports All countries* United States	32,240 15,787	40,196 17,684 1,000	40,149 13,959 1 327	38,138 14,001	39,462 12,239	42,051 15,799 1361	42,187 17,043 1 908	40,918 19,717 1 200	50,264 22,055 1766	61,317 26,727	65,301 30,577 2,593	81,445 33,695	80,037 34,420	69,519 27,664	65,930 25,755 3,047	63,765 20,682
Japan	113	170	1,3 <i>21</i> 243	210	190	167	1,906	238	337	1,951 458	2,392 439	3,032 511	2,236 548	1,924 440	2,04 <i>1</i> 426	2,006 443
Germany ^b	2,562	6,612	8,637	6,945	7,725	6,487	3,281	3,546	5,569	7,933	6,932	9,239	8,930	7,769	7,399	8,123
United Kingdom	8,162	7,221	7,904	8,203	8,488	9,164	11,331	7,070	8,731	7,882	8,665	15,378	12,527	10,631	9,186	9,946
Italy	483	1,397	1,510	1,322	1,546	1,509	1,194	1,163	1,636	1,917	2,484	2,289	2,387	1,801	1,754	1,894
China	- t	2 77	2 4	5 2	47	24	35	9 0	4 5	4 60	5 3	37	330	163	160	174
Jaiwan	5 -	<u> </u>	G 0	င္ပ		2/3	342 1	e <	4	12	16	- 53 - 45	25	35	32	36
Singapore	136	122	98	199	166	384	138	157	181	489	328	250	245	173	181	199
Hong Kong	38	17	23	41	59	37	28	43	29	47	09	20	89	09	52	48
Imports		1					1	0	1	(3			6	1
All countries	24,744	32,735	31,189	29,274	30,961	33,611	34,717	32,796	45,356	55,752	61,041	70,481	69,421	131	58,036	55,130
United States	2,896	4,156	3,882	3,688	4,935	6,532	6,847	5,637	7,120	7,557	8,604	8,761	9,186	8,449	8,032	7,290
Canada	1,393	1,6/3	1,051	8/L,L	1,265	1,605	9 170	7,747	3,479	2,524	2,145	2,285	2,253	1,483	1,290	7,552
Germanyb	1,343	3 174	9 939	3 110	922.6	2,933 2,859	3.231	3.089	3 910	2,349 4 932	6,571	6,47.0 6,556	6.751	5,033	3, 133 4, 872	5.251
France	1,962	4,664	6,410	4,474	5,138	4,590	3,035	3,395	6,525	8,975	8,399	13,183	10,128	8,375	7,608	7,917
United Kingdom	4,119	3,138	2,298	2,927	3,266	3,678	2,992	2,628	4,167	4,614	5,547	4,665	4,371	4,207	4,427	3,706
Italy	730	1,210	626	1,085	1,279	1,250	1,100	866	1,256	1,323	1,766	2,004	1,691	1,241	1,451	1,501
China	197	48	48	302	155	854	929	902	493	798	878	1,185	2,672	2,923	3,387	2,689
South Korea	395	480	306	344	694	009	545	563	1,294	1,335	1,106	1,698	1,761	1,755	1,737	2,126
Taiwan	291	320	640	394	340	429	225	173	179	537	260	1,265	1,359	1,777	1,523	1,683
Singapore	728	472	432	747	828	9/5	618 554	5/7 203	920 336	1,276	962 580	1,33/	1,345	1,554	3/5, L	7,193
BIIDA BIIDLI	707	0	007	/17	607	747	500	080	730	5 5	000	- 45	040	0.77	5 0	000
Apparent consumption																
All countries ^a	114,369	125,019	126,205	126,323	138,069	149,600	159,553	164,616	181,867	193,813	197,091	197,882	198,231	179,800	195,298	188,953
United States	62,838	900,79	71,316	72,952	82,343	88,761	96,963	96,119	100,798	98,243	06/, TOT	100,894	97,19	82,605	96,092	93,253
Japan	4.284	5.076	4,701	5.342	5,709	6.264	6.295	7.056	7,694	7,546	8.733	8,469	9,243	8,170	8,008	7.012
Germanv	4,303	4.634	3,319	4,251	3,542	5,050	6,802	7.377	7,395	9,383	11,987	10,825	9.802	8,815	8,296	8,631
France	8,006	11,839	14,300	11,328	12,732	11,332	9,079	9,418	12,749	15,104	14,464	18,744	13,753	10,750	9,394	9,404
United Kingdom	8,511	8,296	6,549	7,175	7,335	8,655	8,159	11,539	12,206	14,690	15,152	8,615	10,957	10,834	12,523	11,485
Italy	3,656	3,460	3,144	3,123	3,233	3,284	3,551	3,466	4,197	4,220	3,617	3,666	3,044	2,652	2,955	2,951
China	4,071	2,999	3,034	4,089	3,921	6,443	5,814	6,787	6,884	8,737	5,642	6,703	13,631	20,275	22,272	20,020
South Korea	354	414	242	281	542	471	492	532	1,189	1,221	1,035	1,937	1,902	1,899	1,901	2,208
Taiwan	478	547	834	265	521	635	494	439	436	827	838	1,563	1,648	2,099	1,826	1,976
Singapore	707	469	491	793	922	937	808	764	737	1,155	1,008	1,439	1,557	1,820	1,661	1,550
Hong Kong	224	129	240	188	218	220	512	363	195	362	538	741	746	849	529	283
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Appendix table 6-5. Global industry and trade data, by selected countries and industries: 1980-95 (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						Office a	and computing machinery	ting machi	nery							
Production																
All countries ^a	89,805	99,954	110,386	124,913	155,235	161,471	160,899	174,946	200,527	217,434	229,330	234,965	238,019	243,951	260,766	285,557
United States	34,411	38,280	43,467	48,789	61,917	61,467	57,879	61,300	68,376	65,876	64,124	58,553	66,038	68,483	78,909	92,324
Canada	932	1,200	1,257	1,286	1,721	1,958	1,869	1,998	2,550	2,563	2,629	2,651	2,945	3,100	3,721	4,325
Japan	30,007	33,944	37,221	39,512	45,612	51,284	52,582	59,340	67,734	78,999	89,183	96,140	91,153	85,975	80,573	81,311
Germany ^b	6,015	7,074	8,099	10,116	13,028	11,721	10,286	9,318	9,951	10,280	10,748	14,799	13,036	15,368	17,346	18,295
France	4,668	5,068	5,043	5,923	6,862	7,211	7,519	8,190	8,353	8,821	8,608	9,365	9,776	10,119	10,670	11,408
United Kingdom	2,729	2,579	3,011	3,949	5,644	7,282	6,833	8,476	10,870	12,204	12,626	12,107	12,514	12,807	14,767	16,382
Italy	2,570	2,692	2,556	3,578	4,161	2,782	2,753	2,858	5,263	5,795	6,041	5,004	4,700	4,814	4,873	5,369
China	401	344	365	438	539	208	554	616	758	742	563	625	803	1,071	1,274	1,514
South Korea	49	62	53	176	367	489	823	839	1,189	1,261	1,368	1,444	1,449	2,826	4,024	4,712
Taiwan	222	267	296	502	883	1,011	2,063	3,046	3,374	3,558	3,870	4,167	4,304	4,885	4,956	5,695
Singapore	73	83	151	398	669	844	1,464	2,284	3,759	4,746	5,603	5,741	6,497	9,259	11,304	13,075
Hong Kong	127	179	187	463	663	396	453	581	066	1,279	2,084	2,139	1,906	1,740	1,773	1,993
Exports																
All countries ^a	25,953	29.754	33,229	42,445	56,513	64,657	71.643	85,254	106,119	119,139	127.802	138,337	152,726	168,741	192,292	219,557
United States	9,381	10,596	11,178	12,817	16,140	17,007	18,022	21,328	26,146	27,113	29,089	30,605	32,704	32,511	36,919	43,865
Canada	736	903	983	1,142	1,453	1,504	1,582	2,060	2,623	2,448	2,748	3,206	3,695	3,841	5,116	6,381
Japan	2.773	3,282	4.354	7,059	10,414	11,245	13,820	16,106	20,042	21,789	23,594	24,039	25,968	26,048	25,839	26,940
Germany ^b	2,943	3,689	4,026	4,779	5,669	7,280	7,338	7,219	7,726	8,614	8,490	9,076	8,435	8,846	10,007	10,714
France	1,607	2,022	2,021	2,567	3,154	3,543	3,954	4,610	4,862	5,293	5,040	5,693	6,039	6,180	6,778	7,503
United Kingdom	2,140	2,120	2,518	3,127	4,603	5,600	5,625	6,868	8,756	10,040	10,057	10,453	10,360	12,250	13,748	15,929
Italy	1,696	1,372	1,582	1,705	2,016	3,017	2,852	2,792	3,552	4,244	3,838	3,856	3,658	4,631	4,707	5,245
China	7	4	5	12	19	=======================================	47	81	224	194	399	543	1,149	1,659	2,436	3,160
South Korea	77	91	127	249	481	655	1,094	1,636	2,590	2,918	2,690	2,889	3,029	3,471	3,448	4,458
Taiwan	191	246	283	478	927	1,181	2,164	4,083	5,897	7,550	9,156	11,176	14,008	15,033	16,969	19,638
Singapore	111	125	229	602	1,059	1,278	2,216	3,457	2,690	7,185	6,097	10,183	13,102	16,979	21,717	25,783
Hong Kong	463	280	526	952	1,571	1,347	1,300	1,738	2,539	2,790	3,234	3,950	4,975	5,379	6,152	6,693
Imports																
All countries ^a	25,288	29,142	32,600	41,793	55,771	63,637	70,479	84,095	104,784	117,522	126,056	136,517	150,459	165,556	189,097	215,887
United States	2,787	3,645	4,703	7,844	11,778	13,023	15,279	18,664	23,229	26,998	28,141	30,472	36,274	42,103	47,755	55,622
Canada	1,437	1,912	2,029	2,315	3,342	3,285	3,333	4,162	4,754	5,080	5,814	6,633	7,236	7,548	8,426	9,620
Japan	1,023	1,142	1,227	1,333	1,604	1,938	2,227	2,679	3,661	4,510	5,102	5,598	5,950	7,073	9,028	10,763
Germany ^b	3,128	3,385	3,502	4,415	5,391	6,565	7,553	8,906	10,332	12,182	14,034	15,878	16,570	16,469	18,200	20,821
France	2,526	2,801	3,246	3,798	4,364	5,017	5,820	6,479	7,946	8,253	8,299	8,229	8,789	9,208	10,851	12,422
United Kingdom	2,906	3,283	3,807	4,877	6,158	6,548	6,864	8,588	10,928	12,486	12,637	12,666	13,547	15,363	15,866	16,884
Italy	1,478	1,650	1,605	1,769	2,495	3,054	3,328	4,131	4,963	4,829	5,085	5,428	5,552	5,152	5,215	5,533
China	126	130	166	211	875	1,055	752	1,031	971	891	889	1,218	1,709	2,359	2,855	3,311
South Korea	157	172	268	410	422	583	006	904	1,340	1,498	1,723	1,830	1,600	1,813	2,382	2,989
Taiwan	143	187	230	299	411	456	689	945	1,384	1,598	1,774	1,974	2,270	2,266	2,608	3,014
Singapore	207	262	393	644	814	923	1,063	1,663	2,542	2,990	4,118	4,564	5,413	6,873	8,447	10,275
Hong Kong	463	439	437	634	1,021	927	780	1,081	1,657	1,654	2,030	2,507	3,655	3,480	4,342	4,988
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Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

97.812 109,320 120,984 138,826 173,861 183,042 184,920 204,326 29,083 34,733 40,666 48,043 39,883 45,131 61,144 65,774 62,908 32,787 35,875 35,870 39,883 45,310 45,002 4,022 4,022 59,008 32,787 35,875 35,870 39,883 45,310 45,002 4,002 4,024 5,000 2,423 2,544 2,744 3,989 4,116 4,002 4,002 4,024 5,000 2,423 2,000 3,972 3,923 4,097 4,734 6,305 8,184 9,667 10,482 11,340 2,971 3,466 3,153 6,229 6,777 1,222 1,040 3,172 144 387 4,099 672 1,044 1,149 1,149 2,177 1,222 1,040 3,146 1,048 1,044 1,149 1,1	97,812 109,820 120,964 138,826 173,861 183,042 164,920 204,326 237,287 290,889 34,783 40,665 48,043 62,893 63,131 61,144 65,774 4,241 139,069 32,787 35,574 35,877 39,883 45,131 40,022 46,022 50,700 57,311 130,022 13,224 14,097 4,724 14,879 13,909 13,446 13,488 11,849 13,490 13,446 11,640 14,811 12,241 14,097 14,124 14,097 14,124 14,134 14,241 14,149 14,241 14,149 14,241 14,149	183,042 1 63 131							
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20,008 24,743 2,544 2,744 3,959 41,514 41,024 5,755 5,825 6,326 6,326 6,326 6,326 6,327 5,220 2,243 2,544 2,744 3,959 4,1514 4,1514 3,959 4,1514	290.89 34,783 2,646 46,045 66,131 61,144 65,774 74,241 1880 32,767 36,375 55,870 39,883 45,131 61,144 65,774 74,241 74,241 77,322 6,069 22,767 36,375 55,870 39,883 45,310 45,002 50,700 57,311 77,322 6,040 14,831 63,923 4,097 4,724 6,305 8,144 9,425 5,206 11,540 14,881 17,22 13,446 11,534 4,266 15,209 7,370 14,831 188 241 3,846 11,544 17,22 1,1340 14,16 11,568 11,340 14,16 11,230 13,445 13,839 11,544 11,605 11,340 14,811 12,290 13,445 13,899 15,344 11,340 14,811 12,290 13,445 13,899 15,344 13,440 14,811 12,290 14,146 11,542 11,440 14,146 11,542 11,440 11,440 11,441 11,440 11,44	63 131	•••	CA	.,		(1)		368,438
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2.977 2.784 8.187 9.086 11,554 1487 13,987 13,445 13,886 15,584 17,275 13,259 17,272 14,967 17,272 17,967 17,272 14,967 17,272 17,967 17,272 17,967 17,272 17,967 17,272 17,967 17,722 17,967 17,722 17,967 17,722 17,967 17,722 17,967 17,722 17,967 17,722 17,967 17,722 17,967 17,722 17,967 17,722 17,967 1	280,897 316,247 36,374 35,381 34,310 45,310 45,022 50,700 57,311 317,323 4.00 11,554 4.00 11,554 4.00 11,554 4.00 11,554 4.00 11,545 4.00 11,545 4.00 11,545 4.00 11,545 4.00 11,545 4.00 11,546 11,554 4.00 11,546 11,540	4,116							9,303
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0,227 4,724 6,725 7,724 <th< td=""><td>290,897 316,247 3,466 3,153 4,296 6,307 10,482 11,490 12,790 13,923 4,097 4,734 6,305 8,194 3,406 11,490 11,416 11,4831 2,41 387 4,94 672 1,404 1,558 1,281 1,605 1,615 1,615 1,149 2,171 2,988 1,1416</td><td>13,909</td><td></td><td></td><td></td><td></td><td></td><td></td><td>32,124</td></th<>	290,897 316,247 3,466 3,153 4,296 6,307 10,482 11,490 12,790 13,923 4,097 4,734 6,305 8,194 3,406 11,490 11,416 11,4831 2,41 387 4,94 672 1,404 1,558 1,281 1,605 1,615 1,615 1,149 2,171 2,988 1,1416	13,909							32,124
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188 241 353 539 531 702 681 1,668 1,565 2,149 1,535 1,742 1,006 1,266 240 188 234 394 525 331 706 382 1,755 1,742 1,905 1,266 2500.897 316.247 334,407 386,048 431,324 442,150 442,905 456,040 578,049 115,781 15,781 15,781 1,905 1,266 27,887 29,829 31,289 34,639 36,241 53,486 74,175 100,145 100,145 100,145 100,445 10	188 241 353 539 631 702 681 1,068 1,563 290,897 316,247 334,407 365,048 431,324 442,150 458,007 454,985 518,277 518,287 518,277 518,287 518,277 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,287 518,277 518,	1,149							3,456
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Communications equipment 290,897 316,247 354,407 365,048 442,150 458,007 45,498 518,277 566,099 578,249 611,493 610,338 614,213 87,385 22,424 100,498 106,308 124,150 124,400 15,700 107,185 110,403 115,78 120,187 134,943 137,208 87,385 32,429 34,29 34,29 420 107,185 110,403 115,78 120,187 134,943 137,208 1,1223 12,222 12,290 12,280 14,500 15,581 14,77 14,285 15,880 36,990 27,170 201,487 14,900 17,714 14,200 17,714 13,486 17,724 13,486 17,704 41,400 17,729 17,491 17,709 87,71 20,492 20,493 17,404 17,709 87,71 30,403 30,403 30,403 30,403 30,403 30,403 30,403 30,403 30,403 30,403 30,403 30	290,887 316,247 334,407 365,048 431,324 442,150 458,007 454,985 518,277 488 518,277 488 518,277 488 518,277 488 518,277 488 518,277 488 518,277 488 487,384 400,485 11,155 123,447 114,154 42,160 45,17 4,889 5,690 107,135 12,2510 107,135 10,785 19,260 10,785 19,260 10,785 10,280 12,766 14,900 15,381 15,847 17,386 19,390 39,401 17,769 40,401 12,769 39,401 17,785 17,104 16,274 19,161 27,477 4,800 16,284 17,386 19,400 17,825 20,404 4,609 39,401 17,785 17,104 16,274 19,161 27,477 4,609 39,401 17,785 19,400 17,825 20,404 4,609 39,401 17,785 19,401 17,825 19,401 17,825 10,712 10,712 10,712	331							1,805
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87,355 92,424 100,496 106,308 126,020 124,240 125,609 97,200 107,135 110,400 115,578 120,187 134,93 137,208 87,385 3,429 3,429 4,517 4,617 4	87,355 92,424 100,495 106,308 126,020 124,240 125,609 97,200 107,135 3,335 3,429 3,425 3,438 4,209 4,517 4,839 5,694 6,133 87,834 103,847 11,155 123,447 15,1674 15,348 150,053 152,510 178,777 11,223 12,322 12,330 12,766 14,900 15,381 15,847 17,355 19,601 12,801 12,706 13,465 14,800 15,381 18,335 20,404 5,773 5,654 5,800 6,432 6,090 6,003 6,612 7,467 7,769 6,667 5,900 5,569 6,866 9,319 17,104 16,274 17,63 17,83 4,806 5,193 5,325 6,655 8,518 8,839 12,804 17,785 2,327 2,518 2,321 3,013 4,214 4,075 5,344 17,825 2,158 7,966 </th <th>442.150 458.007</th> <th></th> <th>556,090</th> <th>•</th> <th></th> <th></th> <th></th> <th>744.334</th>	442.150 458.007		556,090	•				744.334
3,335 3,429 3,425 3,425 4,267 4,577 4,839 5,694 6,133 6,671 6,597 7,920 8,986 8,449 27,887 29,829 3,425 3,425 3,425 3,425 3,425 3,428 15,547 18,377 18,230 27,771 203,181 18,390 27,887 29,829 12,222 12,290 12,766 14,900 15,381 18,547 17,366 19,390 21,102 23,210 23,181 18,390 11,22 12,222 12,930 12,766 14,900 15,381 18,487 7,768 8,791 8,273 18,488 <	3,335 3,429 3,429 3,429 3,429 3,429 4,517 4,889 5,694 6,133 87,834 103,847 111,155 123,447 151,674 153,469 150,053 152,510 178,777 27,867 29,829 31,288 34,603 36,251 35,366 19,580 19,690 11,223 12,322 12,300 12,766 14,804 17,735 17,814 17,831 18,935 20,404 5,773 5,694 6,886 9,319 17,104 16,274 19,161 27,477 3,116 3,907 3,950 5,362 7,407 7,348 10,752 14,904 17,694 4,806 5,133 2,702 3,163 3,200 2,382 3,334 4,476 4,655 2,327 2,518 2,321 3,013 4,214 4,075 5,334 10,778 4,806 5,138 2,702 3,163 3,200 2,382 3,335 4,476 4,659	124,240 125,609		110.403	•				196,082
87,834 103,847 111,156 123,447 151,674 153,469 150,053 152,510 178,178 194,236 208,703 227,701 203,181 183,903 277,102 203,181 183,903 57,667 29,401 43,781 48,374 52,688 51,935 55,766 17,902 12,786 19,800 15,814 17,326 12,420	87,834 103,947 111,155 123,447 151,674 153,469 150,053 152,510 178,777 27,867 29,829 31,258 34,603 36,251 35,366 37,412 36,809 39,401 11,223 12,322 12,930 12,766 14,900 15,381 15,847 17,356 19,590 5,773 5,654 5,880 6,432 6,090 6,003 6,612 7,467 7,769 6,67 5,900 5,362 7,407 17,144 16,274 19,161 27,467 3,116 3,907 3,950 5,362 7,407 7,348 10,752 14,904 17,835 4,806 5,193 5,235 6,655 8,518 8,839 12,467 7,769 4,806 5,193 5,235 6,655 8,518 8,839 10,772 17,825 2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 2,154	4.517 4.839		6,671					9.725
27,887 29,829 31,288 34,603 36,251 36,809 39,401 43,781 48,374 55,688 51,935 55,768 11,223 12,322 12,980 12,786 14,804 17,735 17,814 17,336 19,590 21,182 23,340 24,718 25,330 24,218 25,232 21,942 19,181 17,814 17,814 17,836 19,590 21,102 21,320 19,482 19,313 18,488 19,482 19,313 18,488 18,273 20,498 20,998 31,431 42,977 31,418 23,943 25,996 31,431 42,977 31,418 23,943 25,996 31,431 42,977 31,418 23,943 25,996 31,431 42,977 42,977 31,418 23,943 25,996 31,431 42,977 31,418 32,907 3,477 41,476 4,659 36,897 25,996 31,431 42,977 31,418 23,907 24,198 21,477 31,148 23,340 24,198 21,477	27,867 29,829 31,258 34,603 36,251 35,366 37,412 36,809 39,401 11,223 12,322 12,930 12,766 14,900 15,381 15,847 17,356 19,590 12,801 12,706 13,465 14,804 17,735 17,814 17,831 18,935 20,404 5,773 5,664 5,800 6,866 9,319 17,104 16,274 17,69 17,69 6,667 5,900 5,569 6,866 9,319 17,104 16,274 19,161 27,477 3,116 3,903 3,950 5,382 12,896 15,494 17,825 2,327 2,518 2,321 3,013 4,214 4,075 5,334 17,825 2,327 2,518 2,327 3,163 3,200 2,382 3,335 4,476 4,659 2,327 2,327 3,163 3,200 2,382 3,335 4,476 4,659 2,154 2,584 <t< td=""><td>153,469 150,053</td><td></td><td>194.236</td><td></td><td></td><td></td><td></td><td>198,080</td></t<>	153,469 150,053		194.236					198,080
11,223 12,322 12,930 12,766 14,900 15,847 17,356 19,590 21,162 23,340 24,218 23,222 21,942 5,773 12,801 12,706 13,465 14,804 17,735 17,811 18,935 20,404 21,101 21,320 19,482 13,131 18,488 6,667 5,880 6,866 9,319 17,104 16,77 31,198 23,943 28,973 8,590 31,431 18,488 3,116 3,907 3,950 5,866 9,866 9,878 10,722 14,904 17,625 18,881 18,989 20,988 14,976 17,477 31,989 15,249 17,825 18,881 18,989 20,988 16,640 3,4476 4,669 3,648 26,148 21,318 2,1476 3,478 2,489 16,640 3,648 2,148 1,788 14,766 4,669 3,948 2,648 2,649 3,648 2,143 4,378 2,143 4,318 2,143 4,31	11,223 12,322 12,930 12,766 14,900 15,381 15,847 17,356 19,590 12,801 12,706 13,465 14,804 17,735 17,814 17,831 18,935 20,404 5,773 5,654 5,880 6,432 6,090 6,003 6,612 7,467 7,769 6,667 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 3,116 3,907 5,382 7,407 7,348 10,752 14,904 17,635 4,806 5,193 6,655 8,518 8,839 12,896 17,785 2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,718 2,154 2,983 2,702 3,163 3,200 2,382 3,335 4,476 4,659 60,780 6,8814 69,104 79,904 97,205 9,696 3,737 4,766 14,70 80,780 2	35,366 37,412		43,781					64,086
12,801 12,706 13,465 14,804 17,735 17,814 17,831 18,935 20,404 21,101 21,320 19,482 19,313 18,486 6,677 5,684 5,880 6,422 6,090 6,003 6,612 7,467 7,789 8,791 8,797 8,890 7,497 19,482 20,409 20,885 1,549 17,104 16,274 19,041 7,789 8,791 8,797 8,690 7,897 3,907 3,908 20,885 7,407 7,489 20,409 20,885 12,889 15,549 17,825 18,581 18,989 20,409 20,088 20,409 20,885 12,896 15,549 17,885 18,789 20,409 20,885 12,896 15,549 17,885 18,789 20,409 20,885 12,896 15,549 17,885 17,879 20,409 20,380 23,348 4,476 4,659 3,688 20,498 15,549 17,885 18,581 8,789 20,498 20,498 20,498	12,801 12,706 13,465 14,804 17,735 17,814 17,831 18,935 20,404 5,773 5,654 5,880 6,432 6,090 6,003 6,612 7,467 7,769 6,667 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 7,116 3,907 3,950 5,382 7,407 7,348 10,752 14,904 17,635 4,806 5,193 5,235 6,655 8,518 8,839 12,896 15,749 17,635 2,327 2,518 2,321 3,200 2,382 3,335 4,476 4,659 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 120,119 145,809 7,589 7,366 7,348 10,711 12,290 11,327 120,119 145,809 8,658	15,381 15,847		21,162					25,160
5,773 5,664 5,880 6,432 6,090 6,003 6,612 7,467 7,769 8,791 8,923 8,977 8,560 7,877 6,687 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 31,188 23,949 25,689 8,977 8,560 3,649 3,689 3,689 12,896 17,825 18,581 18,969 20,380 20,637 25,439 2,286 2,327 2,518 2,327 2,518 2,049 7,271 3,198 20,380 20,637 2,549 2,476 4,659 1,699 20,380 20,637 2,549 2,476 4,659 3,668 2,643 2,476 4,676 6,617 6,049 2,649 3,688 2,617 2,017 2,131 2,222 2,131 2,234 7,268 1,476 4,659 3,668 2,616 1,494 3,688 2,618 2,131 2,222 2,131 2,222 2,319 2,271 2,206 2,699 <td>5,773 5,654 5,880 6,432 6,090 6,003 6,612 7,467 7,769 6,667 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 3,116 3,907 3,960 5,382 7,407 7,348 10,752 14,904 17,635 4,806 5,193 5,235 6,655 8,518 8,839 12,896 17,825 2,327 2,518 2,321 3,163 3,200 2,382 3,335 4,476 4,659 60,780 68,814 69,104 79,904 97,205 9,693 105,677 120,119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 967 1,772 1,344 1,518 2,225 2,39 2,195 2,195 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 2,195</td> <td>17,814 17,831</td> <td></td> <td>21,101</td> <td></td> <td></td> <td></td> <td></td> <td>23,346</td>	5,773 5,654 5,880 6,432 6,090 6,003 6,612 7,467 7,769 6,667 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 3,116 3,907 3,960 5,382 7,407 7,348 10,752 14,904 17,635 4,806 5,193 5,235 6,655 8,518 8,839 12,896 17,825 2,327 2,518 2,321 3,163 3,200 2,382 3,335 4,476 4,659 60,780 68,814 69,104 79,904 97,205 9,693 105,677 120,119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 967 1,772 1,344 1,518 2,225 2,39 2,195 2,195 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 2,195	17,814 17,831		21,101					23,346
6,667 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 31,198 23,943 25,996 31,431 42,977 4,806 5,307 5,386 6,635 6,635 17,404 16,782 14,004 17,635 18,287 20,409 20,846 21,883 24,266 2,377 2,375 6,635 8,518 8,518 20,409 20,846 20,499 20,499 20,846 20,499 20,499 20,846 20,499 20,499 20,846 20,499 20,499 20,846 20,499 17,859 17,875 18,689 2,616 1,849 2,156 2,136 2,136 2,335 4,476 4,659 3,668 2,616 1,499 2,156 2,136 2,136 2,277 2,387 2,476 4,659 3,668 2,616 1,499 2,156 2,136 2,136 2,136 2,136 2,136 2,136 2,136 2,136 2,147 4,659 3,668 2,616	6,667 5,900 5,569 6,866 9,319 17,104 16,274 19,161 27,477 3,116 3,907 3,950 5,362 7,407 7,348 10,752 14,904 17,635 4,806 5,193 5,235 6,655 8,518 8,839 12,896 15,549 17,825 2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 10,178 2,154 2,893 2,702 3,163 3,200 2,382 3,335 4,476 4,659 10,718 12,290 11,327 12,0119 145,809 12,965 1,225 2,391 23,544 1,518 11,417 2,195 2,141 2,368 2,594 2,715 3,228 2,717 3,811 3,853 4,560 5,234 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 1,417 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,097 2,310 2,310 2,317 2,318 2,317 2,318 2,	6,003 6,612		8,791					8,991
3,116 3,997 3,956 5,362 7,407 7,348 10,752 14,904 17,635 18,273 20,409 20,845 21,883 24,296 4,806 5,193 5,235 6,655 8,518 8,839 12,896 15,549 17,825 18,581 18,969 20,380 20,637 25,489 2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,403 6,617 6,892 7,271 7,367 2,154 2,164 2,322 3,363 3,635 4,476 4,659 3,668 2,616 1,849 2,156 2,131 60,780 68,814 69,104 7,904 97,205 98,693 105,677 120,119 14,659 3,668 2,616 2,1349 2,136 2,136 2,136 2,147 2,698 3,668 2,616 1,849 2,136 2,136 2,147 2,698 3,668 2,616 1,849 2,136 2,136 2,148	3,116 3,907 3,966 5,362 7,407 7,348 10,752 14,904 17,635 4,806 5,193 5,235 6,655 8,518 8,839 12,896 15,549 17,825 2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 12,013 14,882 19,470 857 1,272 1,324 1,529 11,327 12,0119 145,809 19,470 18,962 23,901 23,540 27,309 35,172 35,916 2,277 2,006 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 <td< td=""><td>17,104 16,274</td><td></td><td>31,198</td><td></td><td></td><td></td><td></td><td>54,174</td></td<>	17,104 16,274		31,198					54,174
4,806 5,193 5,235 6,655 8,518 12,896 15,549 17,825 18,581 18,969 20,380 20,380 20,637 25,459 2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,413 6,617 6,892 7,271 7,367 2,154 2,154 2,382 3,335 4,476 4,659 3,668 2,616 1,849 2,151 7,367 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,335 7,588 7,965 7,974 4,693 3,606 2,274 2,539 3,522 4,338 4,313 18,962 23,901 22,27 2,206 2,696 35,737 35,272 41,207 44,623 46,281 46,31 45,116 18,962 23,901 23,102 3,11 3,893 35,127 2,2	4,806 5,193 5,235 6,655 8,518 8,839 12,896 15,549 17,825 2,327 2,618 2,321 3,013 4,214 4,075 5,334 7,968 10,178 2,154 2,893 2,702 3,163 3,200 2,382 3,335 4,476 4,659 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 8,967 1,272 1,324 1,518 2,225 2,396 35,737 35,272 41,470 9,672 6,152 2,396 35,737 35,272 41,470 2,066 6,156 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,274 1,355 </td <td>7,348 10,752</td> <td></td> <td>18,273</td> <td></td> <td></td> <td></td> <td></td> <td>31,880</td>	7,348 10,752		18,273					31,880
2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,403 6,617 6,892 7,271 7,367 2,154 2,893 2,702 3,163 3,200 2,382 3,335 4,476 4,659 3,668 2,616 1,849 2,151 7,367 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 2,156 2,131 7,588 7,965 7,942 10,711 12,290 11,327 12,071 2,206 2,699 3,008 3,527 41,807 2,699 3,008 3,527 41,207 44,623 46,281 48,687 47,37 45,116 4,313 1,896 2,390 35,737 35,272 41,207 24,688 1,476 1,404 4,404 4,414 4,404 4,404 4,404 4,404 4,404 4,404 4,404 4,404 4,404 4,404	2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 2,154 2,883 2,702 3,163 3,200 2,382 3,335 4,476 4,659 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,477 2,195 2,445 2,600 3,008 3,401 3,911 3,657 4,603 6,224 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,224 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,224	8,839 12,896		18,581					26,819
60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,355 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,355 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 37,829 957 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,689 3,08 3,522 4,313 1,995 2,340 35,737 35,727 41,207 44,623 46,281 48,887 47,377 45,116 6,162 6,183 7,146 8,199 8,810 9,277 2,140 26,583 29,547 37,88 3,683 4,560 5,234 5,591 6,418 7,414 4,146 7,4	60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 12,0119 145,809 7,588 7,965 7,942 10,711 12,290 11,327 12,013 14,882 19,470 957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9612 11,417 2,195 2,445 2,600 3,008 3,401 3,911 3,863 4,603 6,227 1,356 1,438 1,645 1,740 2,097 2,310 2,374 4,072 4,603 6,227 1,344 1,384 1,645 1,740 2,097 2,310 2,37 2,470	4,075 5,334		6,403					9,255
60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,355 2 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 37,829 35,737 15,28 2,540 27,309 35,172 35,996 35,737 241,207 44,623 46,281 48,687 47,377 45,116 6,195 2,445 2,600 3,008 3,008 3,007 2,309 2,241 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 3,741 8,200 1,345 1,540 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 68 90 103 150 371 107 292 545 1,501 1,345 1,540 3,008 3,242 2,743 2,244 5,200 2,308 3,223 2,440 5,200 2,308 3,223 2,470 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 68 90 103 150 371 107 292 545 1,501 1,345 1,540 1,340 5,000 1,445 1,340 2,097 2,310 2,337 2,470 2,954 3,141 1,507 11,641 13,567 14,408 15,001 2,488 2,721 2,424 2,723 3,253 2,669 3,663 5,618 8,004 9,170 11,641 13,567 14,408 15,001 1,001 2,003 2,404 3,281 3,481 3,281 3,482 2,001 10,049 11,702 13,255 15,395 10,041 10,041 11,041 11,049 11,040 11,041 11,040 11,0	60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 1 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,997 2,310 2,37 2,470 2,954 6 9 0 103 1,50 2,60 2,37 2,470 2,470 2,47	2,382 3,335		3,668					2,487
60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,355 2 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 37,829 967 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,622 4,381 4,313 4,313 18,962 23,540 27,309 35,172 35,996 35,727 41,207 44,623 46,281 48,687 47,377 45,116 6,193 7,126 7,146 8,199 8,810 9,027 9,612 11,408 12,332 13,823 13,627 45,116 2,141 2,386 2,594 2,714 4,072 4,603 6,274 3,618 4,377 4,144 1,355 1,449 2,714 4,	60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 1 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 957 1,272 1,518 2,226 2,319 2,195 2,277 2,206 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,715 3,228 3,741 4,072 4,603 6,227 1,356 1,438 1,645 1,740 2,097 2,310 2,37 2,470 2,954 1,648 1,649 1,740 2,097 2,31 2,27 2,470 2,954 1,648								
7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 37,829 957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,381 4,313 18,962 23,901 23,540 27,309 35,172 35,976 35,772 41,207 44,623 46,281 48,887 45,116 6,152 6,893 7,146 8,199 8,810 9,027 9,612 11,417 12,408 14,887 13,627 14,404 2,195 2,445 2,594 2,718 3,741 3,622 4,591 6,418 7,461 7,417 8,622 2,141 2,388 2,594 2,714 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,76 1,355 1,446 1,740 2,997 2,310 2,337 2,470 <	7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 18,962 23,301 23,540 27,309 35,172 35,996 35,737 35,272 41,207 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,097 2,310 2,37 2,470 2,954 6 90 103 1,56 3,741 4,072 4,603 2,57 1,648 1,645 1,740 2,097 2,310 2,37 2,470 2,954 6 9 1,984	. 68,693	_	_	179,309 1	.,	.,	CA	336,549
967 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,381 4,313 18,962 23,901 23,540 27,309 35,772 35,996 35,772 41,207 44,623 46,281 48,687 47,377 45,116 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 14,404 2,145 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 8,632 2,141 2,388 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,997 2,317 2,470 2,954 3,141 3,221 3,499 3,618 4,300 1,645 1,984 2,006	957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 18,662 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 2,195 2,445 2,716 7,146 8,199 8,810 9,027 9,612 11,417 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,097 2,310 2,37 2,470 2,954 68 90 103 150 2,097 2,317 2,475 1,501 1,645 1,740 2,097 2,317 2,470 7,655 1,501 1,645 1,740 2,097 2,310 2,37 2,470 2,470 2,470 2,470 2,470 2,470 2,470 2,470 2,470	11,327			26,583				59,055
18,962 23,901 23,540 27,309 35,772 35,272 41,207 44,623 46,281 48,687 47,377 45,116 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 14,404 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,617 8,622 2,141 2,388 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,097 2,310 2,954 3,141 3,221 3,999 3,618 4,300 6 90 103 1,740 2,097 2,310 2,954 3,141 3,221 3,999 3,618 4,300 1,645 1,984 2,006 3,673 3,570	18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 6,152 6,883 7,126 7,146 8,199 8,810 9,027 9,612 11,417 2,145 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 68 90 103 150 3,627 3,504 5,270 7,655 1,501 1,645 1,984 2,006 3,627 3,624 5,270 7,655 10,181 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 1,901 2,023	2,319			3,008				5,945
6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 14,404 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 8,632 2,141 2,368 2,534 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 1,03 1,03 1,03 1,03 1,03 1,03 1,03 1,03	6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 1,117 2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,534 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 68 90 103 1,50 371 1,07 292 5,45 1,501 1,645 1,844 2,006 2,696 3,627 3,504 5,270 7,655 10,181 2,488 2,721 2,424 2,793 2,264 2,625 3,664 5,385 8,040 1,901 2,208 2,207 2,444 3,281 3,157 3,518 5,061 7,655	35,996			46,281				51,308
2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 8,632 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 1,355 1,645 1,984 2,006 2,696 3,677 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,488 2,721 2,793 3,253 2,669 3,869 5,902 7,495 8,193 7,781 8,375 10,941 2,172 1,969 2,707 2,764 2,625 3,669 5,495 8,496 9,494 11,702 13,255 15,957 4,017 2,08	2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 68 90 103 150 371 107 292 547 1,501 1,645 1,984 2,006 2,696 3,504 5,270 7,655 10,181 2,488 2,721 2,488 2,721 2,764 2,625 3,859 5,902 7,495 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655	8,810			12,332				19,840
2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 6,90 103 150 371 107 292 545 1,501 1,345 3,068 3,469 4,494 5,000 1,645 1,984 2,000 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,1488 2,721 2,424 2,793 3,253 2,669 3,869 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,107 11,969 2,207 2,764 2,625 3,664 5,385 8,040 9,10,49 11,702 13,255 15,957 14,01 2,208 2,207 2,444 3,281 3,48 6,641 10,49 11,702 13,255 15,373 1,273 1,	2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 68 90 103 150 371 107 292 545 1,501 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 2,488 2,771 2,444 2,764 3,518 5,061 7,655 1,901 2,023 2,444 3,281 3,157 3,518 5,061 7,655	3,911			6,418				11,095
1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 68 90 103 150 371 107 292 545 1,501 1,345 3,068 3,469 4,494 5,000 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,148 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,177 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,167 10,049 11,702 13,255 15,957 14,01 2,013 2,013 2,013 3	1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 68 90 103 150 371 107 292 545 1,501 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655	3,741			8,555				17,613
68 90 103 150 371 107 292 545 1,501 1,345 3,068 3,469 4,494 5,000 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,177 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 1,010 2,018 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,077 14,703 14,703	68 90 103 150 371 107 292 545 1,501 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655	2,310			3,221				5,375
1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 1 0,104 10,049 11,702 13,255 15,957 1 0,104 10,049 11,702 13,255 15,957 1 0,104 10,049 11,702 13,255 15,957 1 0,104 1	1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655	107			3,068				7,765
2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,777 14,773	2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655	3,504			11,641				22,837
2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 15,057 1901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,684 10,523 12,070 14,703	2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655	2,669			7,781				14,861
1 ant 2 208 2 0244 3 2 8 3 157 3 5 18 5 061 7 655 8 4 86 9 664 10 523 12 070 14 7 03	1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655	2,625			10,049				25,615
50.1,1 0.1,21 0.3,10 to 0.0,10 0.0,1 1.00,0 0.1,0 1.0,		3,157			9,664				20,735

Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

				1				!	1							
Activity and country	1980	1981	7881	1983	1984	1985	1986	/861	1988	1989	0661	1991	1992	1993	1994	1885
Imports																
All countries ^a	55,727	63,728	63,704	75,089	92,948	94,269	101,323	115,359	141,360	159,787	172,979	191,586	210,245	232,492	283,892	325,907
United States	10,562	13,842	14,661	20,440	29,458	28,897	28,899	29,672	32,147	37,334	35,043	36,932	44,765	48,983	57,347	67,408
Canada	1,862	2,190	2,068	2,558	3,343	2,935	3,426	3,738	4,515	5,157	6,129	7,150	7,292	7,362	9,116	10,970
Japan	1,134	1,257	1,242	1,651	2,110	1,943	2,453	3,303	4,660	6,308	7,493	7,780	8,187	10,631	14,213	17,864
Germany ^b	5,520	5,597	5,500	6,101	6,627	6,892	7,937	9,297	10,558	11,836	15,238	16,863	16,154	16,726	20,387	22,955
France	2,899	3,178	3,243	2,866	3,336	3,443	4,178	4,954	6,542	6,782	7,979	8,427	7,852	8,344	9,762	10,913
United Kingdom	3,075	4,176	4,719	5,143	5,305	5,611	5,905	7,149	9,005	10,513	10,303	10,180	10,638	11,937	13,629	14,711
Italy	2,415	2,306	2,437	2,244	2,714	3,090	3,562	4,537	5,800	6,545	7,470	7,934	7,451	6,316	7,703	8,590
China	510	99/	518	720	2,013	4,074	2,340	2,810	4,437	4,249	4,012	4,935	6,463	10,214	12,557	14,319
South Korea	1,109	1,193	1,353	2,037	2,447	2,227	2,739	3,672	4,729	5,056	2,587	6,326	6,691	6,932	8,473	10,039
Taiwan	1,238	1,398	1,274	1,646	2,191	1,861	2,788	4,047	5,239	6,040	6,499	7,339	8,935	9,524	10,631	11,783
Singapore	1,928	2,117	2,318	2,940	3,317	3,090	3,631	4,728	6,405	7,532	9,198	10,640	11,913	14,655	19,883	22,459
Hong Kong	1,717	2,010	1,834	2,351	3,397	2,979	3,127	4,587	7,524	7,499	9,629	11,733	14,527	14,543	17,555	20,005
Apparent consumption																
All countries ^a	304,878	332,593	350,590	385,539	457,555	468,897	485,963	486,205	556,021	598,496	623,419	662,058	668,692	676,892	758,009	842,802
United States	92,798	100,904	109,824	119,569	147,252	145,571	146,040	116,970	126,352	132,664	133,042	137,632	157,714	161,353	184,154	224,877
Canada	4,471	4,657	4,493	4,906	5,874	5,705	6,615	7,723	8,995	9,810	10,483	12,448	13,022	12,612	14,570	15,776
Japan	75,559	88,220	95,788	105,850	129,019	130,088	127,380	131,023	154,478	169,194	183,689	201,279	178,098	162,871	182,354	193,040
Germany ^b	30,023	31,654	32,858	36,791	38,386	37,429	40,403	40,844	43,711	48,830	56,869	61,931	60,640	64,628	72,032	76,126
France	12,529	13,727	14,288	13,453	15,775	15,996	17,240	19,018	22,355	23,910	26,693	27,270	25,693	24,078	26,699	28,125
United Kingdom	14,329	15,172	16,310	17,985	20,708	20,722	20,794	22,759	24,912	26,131	25,449	22,826	22,903	21,243	24,055	25,699
Italy	7,332	7,052	7,279	7,579	7,481	7,635	8,699	10,445	11,704	13,353	14,359	14,765	13,726	11,478	13,172	14,039
China	7,113	6,582	5,991	7,449	10,999	21,082	18,355	21,493	30,608	34,282	25,315	27,964	34,070	48,964	53,848	60,930
South Korea	2,885	3,487	3,676	5,218	6,926	6,755	9,255	12,435	14,213	14,146	16,734	16,396	17,152	19,304	21,528	24,179
Taiwan	3,998	4,357	4,520	6,012	8,042	8,513	12,527	14,777	16,970	17,948	19,150	20,916	21,828	26,148	24,430	26,730
Singapore	2,478	2,981	2,995	4,111	5,225	4,978	5,913	8,211	688'6	6,312	7,450	7,792	8,155	8,742	9,084	10,048
Hong Kong	2,462	3,268	3,040	3,709	4,176	3,035	3,871	5,336	6,327	4,558	4,755	5,371	7,329	5,063	5,724	6,241
						Q	Drugs and medicine	nedicines								
Production																
All 00 142100	977 00	108 970	110 011	117 /60	100 010	107 050	100 001	110 000	150 106	155 074	150.000	16/ 0/7	160 001	171 069	100 000	101 740

						۵	Drugs and medicines	nedicines								
Production																
All countries ^a	98,776	106,970	112,241	117,460	123,348	127,252	135,094	143,922	152,126	155,274	159,293	164,947	169,931	171,968	182,830	191,749
United States	23,935	26,094	27,924	30,258	31,160	32,646	35,995	39,300	41,405	43,114	44,918	48,352	51,707	52,005	55,872	56,821
Canada	1,262	1,522	1,560	1,656	1,832	2,228	2,401	2,775	2,814	2,655	2,815	2,787	2,913	3,076	3,251	3,481
Japan	19,704	21,561	23,392	24,932	25,354	26,166	27,708	30,213	31,202	32,334	32,369	32,329	32,379	32,393	33,796	35,762
Germany ^b	9,203	11,164	11,917	12,716	14,096	13,901	12,882	11,794	12,009	13,054	12,725	13,075	12,569	13,757	14,764	15,891
France	3,681	4,550	5,516	5,157	5,296	5,639	5,813	5,764	6,270	7,315	7,815	8,336	9,206	10,002	10,224	10,825
United Kingdom	5,343	5,447	5,978	6,166	6,721	7,068	7,674	8,232	8,616	8,708	8,795	8,931	6,697	9,749	10,402	11,128
Italy	4,331	3,780	3,074	2,935	3,032	2,825	2,833	2,980	2,041	1,895	2,379	2,195	2,222	1,682	1,713	1,792
China	999	921	1,150	1,685	1,678	1,411	1,943	2,704	4,273	3,942	3,421	3,770	3,690	3,577	4,014	4,528
South Korea	940	286	1,150	1,273	1,476	1,558	1,748	1,820	2,416	1,986	2,388	2,206	2,324	2,403	2,505	2,722
Taiwan	208	232	295	298	338	379	469	376	421	358	367	376	404	422	421	442
Singapore	123	139	144	178	240	230	333	384	378	398	392	531	483	478	490	541
Hong Kong	52	99	09	43	63	24	29	69	73	69	09	29	69	61	26	29

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Appendix table 6-5. Global industry and trade data, by selected countries and industries: 1980-95

(Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Exports All countries ^a	17,365	19,856	21,948	21,085	22,010	23,820	25,931	26,271	30,203	29,988	31,134	34,209	38,162	43,509	47,145	50,951
United States Canada	2,683 127	2,894	2,996 182	3,149 206	3,264 184	3,251 186	3,829 213	3,700 237	4,307 203	3,759	3,899	4,086 225	4,584 315	4,634 331	4,838 420	5,10/ 478
Japan	411	452	451	200	501	222	616	627	684	714	787	828	970	924	889	096
Germany ^b	2,717	3,211	3,244	3,321	3,602	3,917	4,031	4,049	4,733	4,694	4,706	5,267	5,422	6,033	6,826	7,423
France	1,623	1,877	3,617	2,071	2,124	2,309	2,393	2,384	2,598	2,815	2,860	3,104	3,499 3,778	4,094	4,156 7,368	4,445
Halv	,033 822	965	6,033	1,027	1,136	1,306	1.256	1,190	1.311	1.187	3,100	1,430	1,712	2,030	2,178	2,373
China	230	240	235	250	276	342	410	433	530	585	648	732	818	807	974	1,075
South Korea	21	30	32	33	38	48	73	75	75	87	92	110	130	134	154	170
Taiwan	28	4	37	36	33	31	36	48	22	89	64	74	8	8	70	7
Singapore	129	127	144	141	115	130	150	147	177	171	174	175	197	280	337	366
Hong Kong	152	184	183	190	180	204	256	331	406	384	407	513	583	525	292	929
Imports																
All countries ^a	15,287	17,536	19,768	18,886	19,952	21,467	23,750	24,470	28,190	28,195	29,647	32,572	36,126	41,238	44,758	48,432
United States	707	933	1,114	1,252	1,480	1,636	1,713	1,746	1,935	2,016	2,067	2,373	2,836	3,347	3,664	4,058
Canada	389	432	484	525	543	494	266	929	675	651	740	821	1,002	1,146	1,218	1,281
Japan	1,204	1,430	1,578	1,506	1,586	1,655	1,995	2,154	2,588	2,427	2,252	2,320	2,541	2,856	3,029	3,225
Germany ^b	1,522	1,561	1,997	1,700	1,827	2,068	2,380	2,429	2,699	2,561	2,785	3,407	3,543	3,592	4,233	4,550
France	867	1,029	1,026	1,068	1,087	1,170	1,286	1,356	1,711	1,958	2,196	2,408	2,774	3,146	3,459	3,726
United Kingdom	657	844	1,099	1,067	1,163	1,260	1,356	1,411	1,732	1,738	1,743	1,978	2,293	2,762	2,950	3,219
Italy	755	904	1,129	1,068	1,177	1,357	1,604	1,657	2,096	2,116	2,330	2,418	2,795	2,886	2,654	2,951
China	19	33	52	99	98	121	175	284	421	307	398	528	531	554	296	681
South Korea	92	88	114	132	155	149	152	163	213	213	236	289	304	329	396	457
laiwan	118	144	165	167	194	202	223	237	245	536	244	267	328	366	407	437
Singapore	114	122	132	125	130	139	150	159	171	182	170	169	193	277	309	332
Hong Kong	225	261	258	254	267	304	348	426	475	451	204	631	829	646	730	276
Apparent consumption																
All countries ^a	102,098	110,902	116,917	121,920	128,271	132,446	141,045	150,322	159,607	162,822	167,508	174,009	179,908	183,424	195,517	205,037
United States	22,833	25,079	27,026	29,400	30,455	32,110	35,156	38,584	40,480	42,638	44,406	48,030	51,526	52,309	56,365	57,540
Canada	1,555	1,813	1,907	2,025	2,236	2,582	2,807	3,173	3,337	3,173	3,392	3,441	3,682	3,976	4,158	4,377
Japan	20,618	22,673	24,652	26,086	26,587	27,430	29,269	31,926	33,309	34,259	34,068	34,047	34,239	34,601	36,202	38,145
Germany ^b	9,240	10,968	12,139	12,597	13,949	13,822	13,053	12,006	12,118	13,048	12,936	13,600	13,148	14,056	15,271	16,354
France	3,370	4,218	3,920	4,726	4,845	5,139	5,369	5,399	6,106	7,243	7,949	8,508	9,461	10,204	10,696	11,286
United Kingdom	4,772	4,888	5,593	2,769	6,343	6,626	7,065	7,720	8,217	8,185	8,237	8,431	9,267	9,391	10,206	10,908
Italy	4,492	4,005	3,511	3,287	3,425	3,292	3,568	3,802	3,205	3,154	3,864	3,736	3,794	3,117	2,901	3,058
China	472	735	886	1,516	1,517	1,228	1,756	2,610	4,234	3,745	3,262	3,674	3,529	3,454	3,798	4,284
South Korea	666 6	1,050	1,239	1,379	1,600	1,668	1,842	1,924	2,570	2,130	2,552	2,407	2,526	2,656	2,780	3,051
laiwan	303	343	430	436	202	200	099	5/5	129	929	096	584 111	899	/36	8//	818
Singapore	130	154	/61	581	2/4	767	35/	420	401	43/	417	222	517	521	919	5/3
Hong Kong	165	191	183	157	197	208	226	251	248	237	264	321	319	321	369	387
	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7															

^aA total of 68 countries are included.

^bGerman data are for the former West Germany only.

[&]quot;High-tech industries include aircraft, office and computing machinery, communication equipment, and drugs and medicines.

SOURCE: WEFA/ICF Global Industry Service (Eddystone, PA: Spring 1997). See figures 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8, 6-9, and 6-10.

Appendix table 6-6. **U.S. trade in advanced technology products: 1990-96** (Millions of U.S. dollars)

Product category	1990	1991	1992	1993	1994	1995	1996
		U.S. €	exports				
Total	94,727.6	101,641.5	107,091.3	108,356.6	120,743.3	138,416.5	154,909.2
Biotechnology	661.2	706.0	745.8	892.7	1,029.2	1,055.5	1,197.4
Life science	4,860.3	5,492.5	5,826.0	6,133.7	6,821.3	8,571.5	9,255.6
Opto-electronics	524.0	627.9	604.0	701.7	926.3	1,164.6	1,418.6
Computers and telecommunications	31,375.0	30,726.3	32,569.2	34,198.8	39,859.3	47,890.5	52,780.1
Electronics	7,535.5	8,925.6	9,968.4	11,987.4	16,235.6	31,391.7	36,548.0
Flexible manufacturing	3,095.7	3,251.4	3,412.6	4,039.0	5,191.0	7,469.6	8,583.6
Advanced materials	6,403.0	6,226.1	7,153.6	8,404.2	10,406.2	4,519.5	1,693.6
Aerospace	36,972.7	41,904.5	42,445.5	37,348.1	34,955.4	30,983.1	38,088.7
Weapons	687.9	851.7	784.1	745.1	730.6	1,040.5	1,466.9
Nuclear technology	1,260.5	1,304.2	1,502.4	1,375.6	1,560.6	1,272.0	1,258.9
Software technology	1,351.8	1,625.2	2,079.7	2,530.2	3,027.9	3,057.9	2,617.7
		U.S. i	mports				
Total	59,381.2	63,252.1	71,871.5	81,233.1	98,116.5	124,787.0	130,361.6
Biotechnology	32.1	48.7	48.8	59.2	73.3	444.8	548.8
Life science	3,417.6	4,305.8	4,821.4	4,607.5	4,821.5	6,607.2	7,291.6
Opto-electronics	1,138.0	2,038.4	2,570.3	2,531.0	2,544.1	2,816.6	3,172.8
Computers and telecommunications	30,110.5	29,153.4	33,848.5	39,790.2	49,440.0	58,865.6	61,346.1
Electronics	10,955.3	12,391.7	14,205.3	17,824.2	25,507.3	38,232.6	36,756.8
Flexible manufacturing	1,676.6	1,789.7	1,684.5	2,222.2	2,899.7	4,947.5	5,740.7
Advanced materials	1,045.6	1,051.5	1,548.4	2,052.9	1,091.8	1,527.6	1,219.8
Aerospace	10,713.8	12,106.0	12,687.2	11,613.3	11,135.6	10,540.5	12,805.4
Weapons	129.9	167.8	156.9	164.7	143.9	205.0	265.5
Nuclear technology	4.5	3.0	5.2	7.9	22.7	39.8	626.1
Software technology	157.4	196.0	295.0	360.0	436.5	559.8	588.0
		U.S. trad	e balance				
Total	35,346.4	38,389.4	35,219.8	27,123.6	22,626.8	13,629.5	24,547.6
Biotechnology	629.1	657.3	697.0	833.5	956.0	610.7	648.6
Life science	1,442.8	1,186.7	1,004.6	1,526.2	1,999.7	1,964.3	1,964.1
Opto-electronics	-613.9	-1,410.5	-1,966.3	-1,829.3	-1,617.8	-1,652.0	-1,754.2
Computers and telecommunications	1,264.5	1,572.9	-1,279.3	-5,591.4	-9,580.7	-10,975.1	-8,566.0
Electronics	-3,419.9	-3,466.1	-4,236.9	-5,836.8	-9,271.7	-6,840.9	-208.8
Flexible manufacturing	1,419.1	1,461.7	1,728.1	1,816.8	2,291.3	2,522.1	2,842.9
Advanced materials	5,357.5	5,174.6	5,605.3	6,351.3	9,314.4	2,991.9	473.8
Aerospace	26,258.9	29,798.5	29,758.3	25,734.8	23,819.7	20,442.7	25,283.3
Weapons	558.0	683.9	627.2	580.4	586.7	835.6	1,201.4
Nuclear technology	1,256.0	1,301.1	1,497.2	1,367.7	1,537.9	1,232.2	632.9
Software technology	1,194.5	1,429.2	1,784.7	2,170.3	2,591.4	2,498.1	2,029.7

 $SOURCE: U.S.\ Bureau\ of\ the\ Census,\ Foreign\ Trade\ Division<<http://www.fedstats.gov>>,\ 1997.$

See figure 6-11.

Appendix table 6-7. U.S. receipts and payments of royalties and fees associated with affiliated and unaffiliated foreign residents: 1987-95 (Millions of U.S. dollars)

			For	eign residents
	Total	Ā	Affiliated	Unaffiliated
		Receipts		
1987	9,914		7,629	2,285
1988	11,802		9,156	2,646
1989	13,064	1	0,207	2,857
1990	16,634	1	3,251	3,384
1991	18,107	1	4,395	3,712
1992	19,715	1	5,718	3,997
1993	20,323	1	5,707	4,616
1994	22,274	1	7,422	4,849
1995	26,953	2	1,619	5,333
		Payments		
1987	1,844		1,296	547
1988	2,585		1,410	1,175
1989	2,602		1,778	824
1990	3,135		2,206	929
1991	4,076		2,996	1,080
1992	5,074		3,381	1,694
1993	4,765		3,364	1,401
1994	5,518		3,810	1,708
1995	6,312		5,148	1,163
		Balance		
1987	8,070		6,333	1,738
1988	9,217		7,746	1,471
1989	10,462		8,429	2,033
1990	13,499	1	1,045	2,455
1991	14,031	1	1,399	2,632
1992	14,641	1	2,337	2,303
1993	15,558	1	2,343	3,215
1994	16,756	1	3,612	3,141
1995	20,641	1	6,471	4,170

NOTE: Details may not add to totals because of rounding.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business, Vol. 76, No. 11 (November 1996).

See figure 6-12.

Appendix table 6-8. U.S. receipts and payments of royalties and license fees generated from the exchange and use of industrial processes with unaffiliated foreign residents, by region/country: 1987-95

	_
	dollars
	U.S.
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•	Ξ

				Be	Receipts								Payn	Payments							-	Balance	٥			
Region/country	1987	1987 1988 1989 1990 1991	989 1	990		1992 1	1993 18	994 1	995	987 1	988 1	1989 18	990 19	1991 199	992 19	993 199	994 1995	5 1987	1988	1989	1990	1991	1992	1993	1994	1995
All countries	1,678	1,962 2	2,051 2	2,333 2	2,434	2,525 2	2,820 3,	,043 3,	,316	459	525 6	112 6	92 28		_	,054 1,056	56 819	1,219	1,437	1,439	1,668	1,638	1,707	1,776	1,987	2,497
Canada	87	09	62	79	62	47	41	53		6	=	œ			0	8		78		54			37	33	42	41
Europe	446	517	530	630	575	637	642	771		320	355 4	433 4				20 734		126	162	97			2	-178	37	255
European Union	353	410	378	200	475	498	496	601		248	279 3	342 3	360 42			472 42	20 401	105		36			81	24	181	251
France	73	85	25	78	9	64	88	129		33							104 109	40		_			64	ကု	25	4
Germany ^a	79	73	22	107	26	108	109	142		100								-21		9			108	-78	14	53
Italy	22	73	89	105	70	66	69	7	28	25	20	22	29	34 2	24	6	2 9	32	53	46	9/	36	75	09	92	51
United Kingdom	09	29	8	9	106	103	103	114		72						123 10		-12		4				-20	우	14
All other	93	107	152	130	100	263	272	315		72		91		211		.09 392		21		61		•		-137	-77	178
So./Central America	64	48	24	29	82	73	۵	84	69	2	*	*	*	-				29		54				Ω	Ž	ΑĀ
Brazil	19	7	4	∞	∞	9	7		∞	*	*	*	*	*				19		4				2	9	9
Mexico	4	13		23	31	59	28		22	က	*	*	*	*	_			=		8				28	32	ΑĀ
All other	31	28	22	28	46	38	۵		33	2	Z A	Z A	₹	-	۵	۵		29		52				Ω	Ž	ΑĀ
Africa	Δ	22	54	22	34	27	36		51	*	4	*	0	*				0		24				36	25	21
Middle East	۵	18	17	22	22	21	33		38	2	က	4	က	4	2			7		5				24	12	23
Asia & the Pacific	936	1,185 1	1,248 1	_	1,638	_	1,966 2,	ď	385	92	•	120		140 15		200 28		841	1,073	1,128	,	1,498	-	1,766	1,794	2,083
Hong Kong	4	9	7	9	9	Ξ	12	œ	51	-	*	*	0	*	*		3 D	က		7				9	2	ΑĀ
India	18	40	56	21	14	34	Δ		32	*	*	*	*	*	*			18		56				¥	58	35
Indonesia	2	2	œ	Ħ	50	13	20		14	0	*	0	0	0	*		*	2		80				20	50	14
Japan	723	883	897 1	1,028 1	1,219 1	1,268 1	1,434 1,	—	,501	88	108	1 60	_	38 14		191 262	32 280	635		788		_	-	1,243	1,111	1,221
Malaysia	*	*	7	7	7		18	19	Ω	0	0	0			0	*	*	¥		Ø	2	2		48	19	Ϋ́
The Philippines	က	4	4	4	7	က	Δ	-	2	0	*	-	0	0	*	*	*	က	4	m		2		¥	_	2
Singapore	30	13	∞	19	7	20	20	73	32	*	0	0	0	*	۵	*	*	30	13	∞	19	21	20	20	73	32
South Korea	34	107	167	249	225	220	278	416	285	*	*	Ω	۵	*	-		9 9	34	•	167	CA	225		277	410	¥
Taiwan	21	46	34	22	22	42	34	39	92	*	*	Ω	_	*	2	2		2	46	34	. 54	22	40	32	37	65
All other	86	81	92	20	72	98	۵	100		9	4	10		2	۵		10 NA	92		85		70		Ž	6	ΑĀ
All other	145	112	116	26	15	16	ΑĀ	Ξ	50	28	40	47		_			_	117		69		13		Ϋ́	Ϋ́	¥

^{* =} less than \$500,000; D = withheld to avoid disclosing operations of individual companies; NA = not available

See figure 6-13.

NOTE: Industrial processes include patents and other proprietary inventions and technology.

^{*}German data prior to 1990 are for the former West Germany only. Beginning in 1990, these data are also for the former East Germany.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business, Vol. 76, No. 11 (November 1996): 90-93.

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Appendix table 6-9. **R&D performance in the United States, by industry: 1973-94** (Millions of current purchasing power parity dollars)

Industry	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983 1	1984 1	1985	1986	1987 1	1988 1	1989 1	1990 1	1991	1992 1	1993 1	1994
Total, all industries	21,250	22,887	24,206	26,997	29,825	33,304	38,226 4	44,505 5	51,810 5	58,650 6	65,268 74	74,800 8	84,239 8	87,823 93	92,155 9	97,015 10	102,055 10	109,727 116,952				119,595
Food, drink & tobacco	269											-		•					1,277	1,386		1,476
Textiles, footwear & leather	64	69	20	85	83	88	101	115	116	136	150	۵.	218	246	243	_			283		313	344
Wood, cork & furniture	71	84	88	107	123	126	139	148	161	159	152	143			137	173	197	245	210		259	269
Paper & printing	194	237	249	313	333	387	445	495	299	999	552	593	929	541	604	788	879	1,059	1,235	1,245	1,643	1,723
Chemicals	3,040	3,541	3,907	4,285	4,611	5,133	5,877			9,516 1	10,219 1	11,027 1	11,436 1	-	12,139 1;	3,816 1	15,134 1	•	18,382 1	18,981		20,701
Industrial chemicals	1,418	1,643	1,766	1,925	2,085	2,272	2,521	2,859	3,540	4,112	4,272				5,535	6,161	6,261	7,004	7,587		8,248	7,557
Pharmaceuticals	869	807	981	1,091	1,117	1,308	1,517			2,492						4,906	5,808	6,287	7,061			9,633
Petroleum refining	498	622	693	167	918	1,060	1,262	1,552			2,258	2,312	_	2,018	. 268,1	1,997	2,180	2,306	2,498	2,277		1,950
Rubber & plastics products	426	469	467	505	491	493	211		775	771	9//			721		752	885	1,153	1,236			1,561
Stone, clay & glass	199	217	233	263	287	324	356	406	460	513	624	733		950	995	738	637	616	483	510		591
Basic metal industries	308	358	443	909	538	260	634	728	878	. 286	1,085	717	740	803	730	637	989	739	714	522		069
Ferrous metals	163	181	215	256	284	314	375	443	555	613	637	381	324	345	252	253	251	238	228	224	289	247
Nonferrous metals	145	177	228	250	254	246	259	285	323	374	448	336	416	458	478	384	435	501	486	298	380	443
Fabricated metal products																						
and machinery	16,232	17,138	17,941	20,023	22,234	24,718	28,318 3	32,970 3	38,306 4	43,003 47	47,780 59	55,040 6	62,076 6	64,443 6	67,874 68	68,440 6	68,507 6	67,201 6	65,297 6	66,351 6	64,628 (59,645
Fabricated metal products	291	313	324	358	386	384	455	220	624	625	701			895	783	881	904		974	1,017	1,158	1,11
Nonelectrical machinery	816	882	926	1,085	1,225	1,400	1,611	1,939	2,417	2,411	2,392	2,404	2,394	2,396	2,428	2,682	2,729	2,753	3,555	3,534	3,431	4,004
Office machinery &																						
computers	1,733	2,103	2,220	2,402	2,655	2,883	3,214	3,962	4,401	2,667		8,100 (9,822	9,794	9,347 1			11,693 1	11,220 1	11,404	9,313	9,664
Electrical machinery	1,834	2,047	2,121	2,382	2,295	2,476	2,775		3,476	2,858	2,815	1,848				1,419	2,126	3,444	3,091	2,722	2,537	2,664
Electronic equipment																						
& components	3,068	2,964	2,984	3,254	3,591	4,031	5,049	6,127	6,853	8,065	9,866	11,930 1	13,155 1	13,730 1	14,609 13	12,709 1	11,192	9,956 1	10,324 1	10,638 1	10,812	12,674
Shipbuilding	I	I	I	I	I	I	I			I	I			I	I	I	I		I	I	I	I
Motor vehicles	2,405	2,389	2,340	2,778	3,358	3,879	4,509		4,806	4,797	5,318 (6,057			9,279 1	10,085 1			10,388	9,924 1		13,406
Aerospace	5,052	5,278	5,713	6,339	7,033	7,536	8,041	•	11,968 1	14,451 1	15,406 18	18,858 2	22,231 2	21,050 2	24,458 24	24,168 2	22,331 2	20,635 1	16,629 1	17,158 1	15,056 1	14,260
Transport equipment	72	87	06	94	120	131	159	162	147	199						522	208		411	412	409	421
Instruments	961	1,075	1,173	1,331	1,571	1,998	2,505		3,614	3,930	4,266	4,602	5,013	5,103		5,530	5,992		8,705	9,542 1	10,119	11,441
Other manufacturing	158	177	205	217	243	266	288	364	444	519	541	379	361	382	383	420	449	613	624	099	831	898
Total services	715	768	735	845	928	1,229	1,540	1,815	1,906	2,472		4,905	6,714	7,446	7,844 1	10,513 1	14,031	20,793 2	28,446 2	28,933 2	26,468	23,288
SOURCE: Organisation for Economic Co-operation and Development, Analytic	ic Co-ope	ration an	d Develop	ment, An	ल	Business Enterprise R&D Database (Paris: April 1997)	terprise l	3&D Data	base (Par	ris: April 1	.(266											

See figure 6-15.

Appendix table 6-10. **R&D performance in Japan, by industry: 1973-94**(Millions of current purchasing power parity dollars)

Industry	1973	1974	1975	1976	1977	1978	1979	1980	1981 1	1982	1983 19	1984 19	1985 1	1986 19	1987 19	1988 19	989 19	1990 18	1991	1992 19	993 1	1994
Total, all industries Total manufacturing	5,052 4,792	5,559	6,037 5,692	6,643 6,289	7,445	8,322 10	10,249 12 9,725 11	12,536 15 11,906 14	15,257 17 14,580 16	17,703 20, 16,978 19	20,411 23, 19,545 22,	23,284 27, 22,296 26,	27,283 28 26,282 27	28,313 30, 27,278 29,	30,945 35, 29,862 34;	35,483 41, 34,176 39,	41,400 47, 39,891 45,	47,450 50 45,575 48	50,304 51 48,418 49	51,203 49 49,016 46	49,123 49 46,892 47	49,590 47,373
Food, drink & tobacco	137	135	165														٥.	2				1,291
Textiles, footwear & leather	85	73	81	74					271	227	228	_	287	290		358	409	452	474			424
Wood, cork & furniture	12	15	22	56	59					22	92	09										177
Paper & printing	66	63	69	62						121									473	_		405
Chemicals	1,135	1,299	1,419	1,516	2					•									_	_		365
Industrial chemicals	674	787	813																			3,058
Pharmaceuticals	250	277	341	387	425	489	089	757			1,298 1,	1,339 1,			1,814 2,0		2,293 2,	2,643 3	3,047 3		3,414	3,494
Petroleum refiningRubber & plastics	20	24	61	94	92																	438
products	161	181	204	210	244	273	306	359														1,375
Stone, clay & glass	108	133	150	184	186	212	280	332												~		600'ı
Basic metal industries	310	375	413	453	475	517	614	908	998 1	1,117	1,164 1,	1,268 1,	1,566 1	1,691	1,666 1,8	1,819 1,	1,987 2,	2,275 2	2,628 2	2,452 2	2,358 2	2,085
Ferrous metals	231	281	320	352	366	392	461	287			~				•				_	~		1,313
Nonferrous metals	78	94	93	101	109	125	152	219		316									_			773
Fabricated metal products																						
and machineryFabricated metal	2,858	3,134	3,307	3,724	4,214	4,822	5,919 7	7,128 9	9,086 10	10,723 12	12,504 14,	14,384 17,	17,176 17	17,578 19,	19,140 22,	22,197 26,	26,220 30,	30,715 32	32,008 32	32,167 30	30,426 31	31,144
products	8	8	105	143	136	145			272										402	629	653	617
Nonelectrical machinery	466	647	683	663	843	764	936	1,174 1	1,389 1	1,596	1,772 1,	,997 2,	,300 2	,341 2,	,536 2,	2,779 3,	,389 4,	4,104 4	,334 4	,265 4	,349	1,615
Office machinery &	7	5	1	0	C	Ċ	Ċ				•	٦						•				Š
computers	- [0 [90 L	137	192	239	7 62		,	202	7 12	901	, , ,	. 08c,	, , , , , ,	2,224 2,3	2,902 4,	4,007	4,004	7 7 6	_	4,651	4,734
Electrical machinery Electronic equipment	0/9	228	/60	827	608	0/6	1,198	1,122			.N	N	. •					O		5,181,5		1,561
& components	756	865	818	686	922	1,082	1,357	1,980			•				5,585 6,3	6,311 6,	6,656 7,	_			3 069'	3,190
Shipbuilding	44	46	45	41	35	30																87
Motor vehicles	290	631	685	761	926	1,177		1,601 2	2,102 2	2,374 2			3,494 3		3,774 4,		5,389 6,	6,547 6	6,527 6	6,785 5		5,519
Aerospace	26	62	74	27	29	73				_										353	381	316
Transport equipment	28	12	14	56	36	46				_										95		104
Instruments	120	121	129	153	202	251	297	396	533				926			•			•	•		1,842
Other manufacturing	53	29	29	69	80	83	92	138	142	161	167	201	212	244	260	279	312	356	_			473
Total services	225	220	294	299	373	373	464	229	602				881			'		,667 1	,648 1	,993	,034	2,042

SOURCE: Organisation for Economic Co-operation and Development, Analytical Business Enterprise R&D Database (Paris: April 1997).

See figure 6-15.

Science & Engineering Indicators – 1998

Appendix table 6-11. **R&D performance in the European Union, by industry: 1973-94**(Millions of current purchasing power parity dollars)

Industry	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total, all industries	12,282 11,201	13,777	12,282 13,777 15,467 17,134 18,782 11,201 12,632 14,047 15,551 17,016	17,134		21,543 2	25,759 2	28,828 3 26,505 3	_			42,036 4 38,801 4	47,819 5	51,872 5 46,241 4	55,935 6 49,994 5			71,186	73,569 65,399	78,669 68,365	76,804 66,476	77,813 67,486
Food, drink & tobacco Textiles, footwear & leather	133	161	328 161	363 158	390 152			5/4 167	294 169	032 178	192			245	938 241	98 I 248	1,134			365	397	1,413 447
Wood, cork & furniture	14	16	16	17				61	64	9/				121	122	122				160	160	184
Paper & printing	85	88	92	101				172	188	206				281	307	318	362	400	394	393	379	422
Chemicals	2,824	3,232	3,707	4,149	4,554	5,071	5,776	6,516	7,586	8,339		9,536 1	0,724 1	1,396 1	2,698 1	. 4,138	15,417	16,632	16,783	17,889	17,596	17,667
Industrial chemicals	1,641	1,913	2,205	2,476	2,689	2,869	3,167	3,639	4,257	4,597	4,732		5,942	6,308	968'9	7,563	8,006	8,366	8,284	8,528	8,112	8,099
Pharmaceuticals	753	855	066	1,121	1,248	1,521	1,801	1,944	2,205	2,526			3,353	3,638	4,341	5,004	5,674	6,423	6,694	7,565	7,683	7,819
Petroleum refining Rubber & plastics	223	241	267	291	300	318	354	403	514	545			637	647	639	699	711	802	851	781	715	645
products	208	224	244	261	316	363	454	530	610	672	229	718	791	803	821	905	1,026	1,038	984	1,015	1,086	1,104
Stone, clay & glass	156	177	182	193	210	250	302	332	329	392	424	444	479	475	514	547	619	617	647	682	029	691
Basic metal industries	312	395	433	454	467	909	586	650	733	799	846	867	918	911	937	1,002	1,045	1,080	1,106	1,124	1,041	1,089
Ferrous metals	223	262	297	305	309	334	404	441	504	547	581	592	637	619	634	692	713	717	770	811	738	787
Nonferrous metals	88	133	135	149	159	172	182	208	229	252	265	275	281	292	303	309	332	363	336	313	303	302
Fabricated metal products																						
and machinery	7,377	8,209	9,061	9,061 10,021 10,998		12,937	15,732 1	17,899 2	20,259 2	22,356 2	23,900 2	26,525 3	30,320	31,787 3	34,076 3	36,738	39,993	43,150	44,547	46,184	44,616	45,358
Papiliote IIIelai	117	130	787	180	000	305	74	700	57.4	a	75.1	CUa	000	aco	057	9	1 086	1 021	7	400	105	701
Nonellastines	- 0	60 60 60 60 60 60 60 60 60 60 60 60 60 6	100	100	770	200	1 4 5	190	4 7 7	000		200	300	920	937	1,019	000,1	162,1	1,110	1,120	1,123	1,104
Nonelectrical machinery Office machinery &	820	883	986	con, I	1,201	1,52,1	766,1	2,102	2,412	7,090		3,000	3,402	3,558	3,907	4,302	000,6	9,0,6	2,201	5,8	0/0,6	5,899
computers	374	415	481	296	731	816	932	1,004	1,166	1,326	1,460	1,755	2,074	2,107	2,302	2,604	2,851	2,980	3,118	3,036	2,761	2,470
Electrical machinery	993	1,159	1,282	1,400	1,462	1,650	1,867	2,059	2,320		2,722		3,751	4,220	4,439	4,508	4,437	4,445	5,232	5,249	5,214	5,251
Electronic equipment																						
& components	1,796	2,077	2,378	2,637	2,934	3,649	4,520	5,262	5,993		7,138	7,786	8,685	8,843	Ϊ.	. 215,01	11,042	11,888	11,294	11,719	11,446	11,967
Shipbuilding	98	88	88	95	92	93	86	90	92		122	140	145	158		139		196	180	240	233	239
Motor vehicles	1,263	1,361	1,489	1,667		2,211	2,673	2,993	3,371		4,192	4,696	5,288	5,656		6,925		8,592	9,306	10,170	10,262	10,425
Aerospace	1,695	1,825	1,920	2,074	2,117	2,303	2,823	3,310	3,730		3,997	4,492	5,246	5,455		5,892		7,553	7,681	7,392	6,403	6,358
Transport equipment	24	28	59	44	63	62	99	75	06	108	132	153	155	161	171	175	167	207	322	294	312	339
Instruments	209	224	242	258	273	327	397	453	209		537	579	675	702		795	852	980	1,036	1,137	1,190	1,225
Other manufacturing	26	28	64	94	117	129	120	134	110		122	114	118	138	162	156	156	179	180	199	207	216
Total services	749	898	1,003	1,128	1,300	1,387	1,518	1,618	1,849	2,093	2,289	2,454	2,853	4,634	4,948	5,614	6,292	6,626	7,147	8,613	9,114	9,121

NOTE: The member countries of the European Union are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. SOURCE: Organisation for Economic Co-operation and Development, Analytical Business Enterprise R&D Database (Paris: April 1997).

See figure 6-15.

Appendix table 6-12. Number of U.S. patents granted, by inventor residence, inventor sector, and year of grant: 1963-95

Inventor residence/sector	Total 1963-95	1963-82	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TOTAL	2,401,282	1,234,646	57,888	56,860	67,200	71,661	70,860	82,952	77,924	95,537	90,364	96,513	97,441	98,342	101,675	101,419
Inventor residence	407 060	200	900	00 00	730 00	777	00	004	90707	100	7 2007	7	010	200	100	700
Foreign origin	903,313	369,549	23,992	23,989	28,833	32,106	32,734 32,734	39,432	40,496 37,428	30, 163 45,352	42,977	31, 102 45,331	32,232 45,189	45,111	36,063 45,610	33,739 45,680
Argentina	869	417	18	21	20	Ξ	17	18	16	20	17	16	20	24	32	31
Australia	9,010	3,584	266	237	292	340	374	389	416	503	432	463	410	378	467	459
Austria	8,653	4,083	229	267	256	318	357	345	337	333	393	328	370	313	289	338
Brazil	8,620	4,459 330	224 27	202 102	240	240	243 27	282	305 20	905 905	ა ა £	324 61	324	330 57	- cs - cs	785 83
Bulgaria	465	246	13 5	5 6	52	2 2	2 5	32 5	23	9 9	27	5 은	t v		8 4	3 -
Canada	43,063	20,252	066	1,000	1,206	1,342	1,314	1,594	1,489	1,959	1,862	2,035	1,964	1,944	2,008	2,104
China	545	107	0	- ;	2	- ;	၈	23	47	25	47	52	14	23	48	62
Czechoslovakia	2,090	1,637	5 50	88 t	33	54	35	46	33	34	33	27	103	13	19	15
Finland	2,020	1,330	125	116	167	200	210	275	232	230	304	331	360	293	312	358
France	72,156	35,247	1,975	1,895	2,162	2,400	2,369	2,874	2,661	3,140	2,866	3,030	3,029	2,908	2,779	2,821
Germany	188,830	91,571	5,467	5,477	6,323	6,718	6,856	7,885	7,353	8,353	7,612	7,680	7,310	6,893	6,732	009'9
Hong Kong	843	243	œ ç	4 5	54	52	ب ق	34	4 5	4 6	25	50	00 0	9 2	57	8 8
Hungary	2,242	90.	711	9 7	= ç	20 5	<u> </u>	77	5 7 7	87.	3 6	8 8	8 8	9 6	오 5	3 2
India	862 862	268	4 4	4 6	2 65	20 8	2 ∞	¥ 85	4 43	<u>-</u> 6	S 5	22.52	25 25	23	20	25
Israel	4,866	1,317	114	109	162	179	189	245	238	326	299	305	335	314	350	384
Italy	26,920	11,960	752	625	794	919	966	1,183	1,076	1,297	1,260	1,209	1,271	1,286	1,215	1,078
Japan	313,267	77,458	8,149	8,793	11,110	12,746	13,209	16,557	16,158	20,168	19,525	21,027	21,926	22,293	22,384	21,764
Liechtenstein	473	274	6 6 6	15	16	13	9 7	9 6	2 6	∓ 8	1 2	- 1	16	- 8	9 9	17
Luxembourg Mexico	267 1 614	1 076	35.0	32	42	33	37	7 5	23 44	8 8 8 8	2 6	72	9 8	7 5 45	2 4	42 4
Netherlands	22,609	11,104	619	626	726	766	722	922	806	1,060	959	992	854	90	853	799
New Zealand	1,107	452	44	38	20	33	25	89	22	28	25	4	44	33	37	4
Norway	2,890	1,415	65	99	87	06	8	135	121	126	112	=	108	117	126	130
Poland	626	451	26	20	5 5	Ξ 8	4 6	13	ω ς	4 5	7,	ω ι	1 2	∞ ε	∞ ξ	ω ς
South Africa	2,615	852,L		09	85 8	96.	88 9	/OL	103	134	375	105 201	/6	93	דטר	22.
Spain	2,049 0,798	1 2 1 9	4 4	0 20	ဂ တ	- K	940	1.0	126	13.9	130	153	133	159	945 141	1,101
Sweden	23,939	13,370	685	623	707	857	883	948	777	837	292	716	627	635	200	806
Switzerland	38,553	21,623	1,147	1,017	1,174	1,233	1,212	1,373	1,245	1,363	1,284	1,335	1,196	1,126	1,169	1,056
Taiwan	9,229	316	88	92	66	174	208	343	457	591	732	904	1,000	1,189	1,443	1,620
United Kingdom	85,837	51,143	2,132	1,930	2,269	2,494	2,405	2,775	2,579	3,094	2,789	2,799	2,425	2,294	2,234	2,475
Vocation	0,963	5,129	802 F	77.7	717	14/	- 5	2 6	S 6	<u>-</u> 6	4 6	ر ا	8 8	3 2	3 8	2 8
Others (113 countries)	4,059	2,142	73	7.	- 68	110	90	107	102	153	119	143	151	166	254	289
Inventor sector																
U.S. corporation	1,145,904	654,518	25,783	25,677	29,999	31,181	29,490	33,726	31,437	38,664	36,093	39,133	40,307	41,826	44,035	44,035
U.S. individual	365.564	23,023	8,553	7.574	8.911	9.265	9,477	10.887	10.122	13.028	12.542	13.207	12.751	12.281	12.805	12.885
Foreign corporation	711,249	269,314	18,856	19,246	23,238	25,957	26,545	32,371	30,960	37,506	35,548	37,594	38,237	38,401	38,788	38,688
Foreign government	9,638	3,748	369	339	438	483	479	555	453	441	423	472	463	434	296	245
	704,470	00,100	0,022	2,310	6.0,0	0,000	, 0,0	4,t	61 7,4	0,0	2 2,4	t 70,'t	4,022	t 0 7,	£ £	1,000

SOURCE: U.S. Patent and Trademark Office, Patenting Trends in the United States, 1963-95 (Washington, DC: 1996).

See figures 6-16, 6-17, and 6-18.

Appendix table 6-13. Patent classes most emphasized by inventors from the United States patenting in the United States: 1985 and 1995

		Paten	ts granted t	o inventor	s from:		
		All co	untries	United	States	Activit	y index
Paten	t class number and title	1985	1995	1985	1995	1985	1995
166	Wells	336	338	306	285	1.783	1.667
606	Surgery	154	602	103	484	1.310	1.590
604	Surgery	298	843	232	674	1.524	1.581
607	Surgery: light, thermal, and electrical application	94	293	71	211	1.479	1.424
585	Chemistry of hydrocarbon compounds	225	223	168	158	1.462	1.401
206	Special receptacle or package	262	404	183	280	1.368	1.370
128	Surgery	290	846	164	582	1.107	1.360
220	Receptacles	182	230	101	155	1.087	1.332
248	Supports	211	247	135	166	1.253	1.329
380	Cryptography	47	204	34	137	1.416	1.328
052	Static structures (e.g., buildings)	313	315	201	207	1.257	1.299
426	Food or edible material: processes, compositions, and products	438	479	287	309	1.283	1.275
273	Amusement devices: games	108	331	65	213	1.178	1.272
134	Cleaning and liquid contact with solids	84	224	58	144	1.352	1.271
436	Chemistry: analytical and immunological testing	126	280	90	180	1.399	1.271
326	Electronic digital logic circuitry	115	333	67	211	1.141	1.253
435	Chemistry: molecular biology and microbiology	385	1,346	229	852	1.165	1.252
530	Chemistry: natural resins or derivatives; peptides	134	271	85	171	1.242	1.248
342	Communications: directive radio wave systems and devices	109	274	57	172	1.024	1.241
395	Information processing system organization	550	3,025	355	1,874	1.264	1.225
062	Refrigeration	423	515	240	315	1.111	1.209
210	Liquid purification or separation	452	782	254	478	1.100	1.209
239	Fluid sprinkling, spraying, and diffusing	230	240	132	146	1.124	1.203
424	Drug, bio-affecting and body treating compositions	404	1,166	221	705	1.071	1.195
015	Brushing, scrubbing, and general cleaning	135	229	84	138	1.218	1.192
362	Illumination	171	330	109	199	1.248	1.192
379	Telephonic communications	244	733	147	438	1.180	1.181
297	Chairs and seats	154	223	69	132	0.877	1.170
361	Electricity: electrical systems and devices	463	763	269	450	1.138	1.166
200	Electricity: circuit makers and breakers	273	207	159	122	1.140	1.165
340	Communications: electrical	381	598	184	351	0.946	1.161
137	Fluid handling	531	427	324	250	1.195	1.158
235	Registers	106	321	46	187	0.850	1.152
029	Metal working	604	699	365	404	1.183	1.143
536	Organic compounds—part of the class 532–570 series	95	320	39	183	0.804	1.131
174	Electricity: conductors and insulators	201	349	120	199	1.169	1.127
280	Land vehicles	285	581	93	331	0.639	1.126
439	Electrical connectors	496	810	349	459	1.378	1.120
073	Measuring and testing	938	1,100	526	619	1.098	1.113
053	Package making	289	351	138	197	0.935	1.110
324	Electricity: measuring and testing	409	893	237	501	1.135	1.109
315	Electric lamp and discharge devices: systems	236	332	145	185	1.203	1.102
162	Paper making and fiber liberation	163	208	75	115	0.901	1.093
502	Catalyst, solid sorbent, or support therefor: product	425	302	279	167	1.285	1.093
341	Coded data generation or conversion	170	280	84	152	0.968	1.073
330	Amplifiers	247	241	119	130	0.943	1.067
427	Coating processes	555	691	298	370	1.051	1.059
385	Optical waveguides	178	504	100	269	1.100	1.055
568	Organic compounds—part of the class 532–570 series	365	302	221	160	1.186	1.048
156	Adhesive bonding and miscellaneous chemical manufacture	546	779	327	412	1.173	1.046
414	Material or article handling	316	324	170	171	1.053	1.044

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in

Appendix table 6-14.

Patent classes most emphasized by inventors from Japan patenting in the United States: 1985 and 1995

		Pater	nts granted t	to inventor	s from:		
		All co	untries	Jap	oan	Activity	/ index
Paten	t class number and title	1985	1995	1985	1995	1985	1995
369	Dynamic information storage or retrieval	277	658	158	508	2.671	3.003
354	Photography	355	471	245	332	3.232	2.742
084	Music	101	220	63	151	2.921	2.670
355	Photocopying	422	753	213	489	2.364	2.526
358	Facsimile or television recording	248	629	169	395	3.191	2.443
400	Typewriting machines		206	86	118	1.900	2.228
365	Static information storage and retrieval	228	897	95	489	1.951	2.121
360	Dynamic magnetic information storage or retrieval	476	789	271	411	2.666	2.026
257	Active solid-state devices (e.g., transistors, solid-state diodes)	294	1,308	107	675	1.704	2.008
430	Radiation imagery chemistry: process, composition, or products		1,421	392	732	2.464	2.004
347	Incremental printing of symbolic information		486	184	247	2.693	1.977
359	Optics: systems (including communication) and element		1083	198	521	1.689	1.871
310	Electrical generator or motor structure		386	104	175	1.586	1.764
348	Television		1028	179	461	1.473	1.744
148	Metal treatment		352	68	156	1.415	1.724
345	Selective visual display systems		356	48	146	1.414	1.595
271	Sheet feeding or delivering		247	54	101	1.453	1.591
372	Coherent light generators		364	27	140	0.996	1.496
118				53	107	1.193	1.445
382	Coating apparatus		288 323	43	120	1.193	1.445
	Image analysis						
242	Winding, tensioning, or guiding		310	118	113	1.506	1.418
318	Electricity: motive power systems		371	120	134	1.557	1.405
123	Internal-combustion engines		727	558	260	2.369	1.391
333	Wave transmission lines and networks		213	29	75	0.813	1.370
364	Electrical computers and data processing systems		1,529	221	512	1.489	1.303
428	Stock material or miscellaneous articles		1,890	382	630	1.397	1.297
371	Error detection/correction and fault detection/recovery		431	28	141	0.923	1.273
425	Plastic article or earthenware shaping or treating		290	33	92	0.588	1.234
437	Semiconductor device manufacturing: process		1362	106	431	1.306	1.231
363	Electric power conversion systems		206	28	65	1.009	1.227
501	Compositions: ceramic		215	47	67	1.550	1.212
313	Electric lamp and discharge devices	221	282	50	87	1.059	1.200
303	Fluid-pressure and analogous brake systems	78	202	24	62	1.441	1.194
327	Miscellaneous active electrical nonlinear devices	302	627	88	192	1.364	1.191
356	Optics: measuring and testing	340	669	79	200	1.088	1.163
455	Telecommunications	158	403	40	120	1.185	1.158
523	Synthetic resins or natural rubbers—part of the class 520 series	277	210	58	62	0.980	1.149
429	Chemistry: electrical current producing apparatus,						
	product and process	221	387	47	114	0.996	1.146
250	Radiant energy		993	149	287	1.297	1.124
395	Information processing system organization		3,025	131	871	1.115	1.120
341	Coded data generation or conversion		280	52	79	1.432	1.098
381	Electrical audio signal processing systems and devices		217	46	61	1.528	1.094
526	Synthetic resins or natural rubbers—part of the class 520 series		363	80	101	1.319	1.082
074	Machine element or mechanism		290	121	80	1.552	1.073
417	Pumps		237	64	65	0.979	1.067
525	Synthetic resins or natural rubbers—part of the class 520 series		726	132	199	1.122	1.066
439	Electrical connectors		810	38	219	0.359	1.052
060	Power plants		547 260	85 20	147	1.047	1.045
101	Printing		269 725	29	72 104	0.689	1.041
524	Synthetic resins or natural rubbers—part of the class 520 series		725 507	98	194	0.691	1.041
219	Electric heating	627	527	191	139	1.426	1.026

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in 1995.

Appendix table 6-15.

Patent classes most emphasized by inventors from Germany patenting in the United States: 1985 and 1995

		Paten	ts granted	to inventors	s from:		
		All co	untries	Gerr	many	Activit	y index
Pater	nt class number and title	1985	1995	1985	1995	1985	1995
303	Fluid-pressure and analogous brake systems	78	202	21	68	2.577	4.576
101	Printing	197	269	52	90	2.526	4.548
188	Brakes	182	223	23	61	1.210	3.719
198	Conveyors: power-driven	233	271	27	51	1.109	2.558
548	Organic compounds—part of the class 532–570 series	212	281	41	52	1.851	2.516
072	Metal deforming	299	235	34	41	1.088	2.372
546	Organic compounds—part of the class 532–570 series	209	232	23	40	1.053	2.344
123	Internal-combustion engines	1,103	727	167	123	1.449	2.300
271	Sheet feeding or delivering	174	247	22	38	1.210	2.091
378	X-ray or gamma ray systems or devices	122	234	27	35	2.118	2.033
425	Plastic article or earthenware shaping or treating	263	290	42	43	1.528	2.016
568	Organic compounds—part of the class 532-570 series	365	302	44	43	1.154	1.936
549	Organic compounds—part of the class 532-570 series	214	235	31	33	1.386	1.909
074	Machine element or mechanism	365	290	40	40	1.049	1.875
528	Synthetic resins or natural rubbers—part of the class 520 series	411	531	58	69	1.351	1.767
524	Synthetic resins or natural rubbers—part of the class 520 series	664	725	85	94	1.225	1.763
451	Abrading	195	209	25	27	1.227	1.756
242	Winding, tensioning, or guiding	367	310	60	40	1.565	1.754
423	Chemistry of inorganic compounds	590	390	85	49	1.379	1.708
525	Synthetic resins or natural rubbers—part of the class 520 series	551	726	51	87	0.886	1.629
252	Compositions	785	1,039	73	119	0.890	1.557
248	Supports	211	247	23	28	1.043	1.541
204	Chemistry: electrical and wave energy	326	426	21	45	0.617	1.436
417	Pumps	306	237	43	25	1.345	1.434
073	Measuring and testing	938	1,100	109	115	1.112	1.421
422	Chemical apparatus and process disinfecting,		.,				
	deodorizing, preserving, or sterilizing	211	526	27	55	1.225	1.421
106	Compositions: coating or plastic	207	393	36	41	1.664	1.418
297	Chairs and seats	154	223	27	23	1.678	1.402
222	Dispensing	249	339	21	34	0.807	1.363
239	Fluid sprinkling, spraying, and diffusing	230	240	23	24	0.957	1.359
075	Specialized metallurgical processes, compositions for	190	212	21	21	1.058	1.347
414	Material or article handling	316	324	32	32	0.969	1.343
205	Electrolysis: processes, compositions used therein	301	266	31	26	0.986	1.329
526	Synthetic resins or natural rubbers—part of the class 520 series	284	363	19	35	0.640	1.311
342	Communications: directive radio wave systems and devices	109	274	12	26	1.054	1.290
053		289	351	31	32	1.034	1.239
523	Package making	277	210	30	19	1.027	1.239
	Synthetic resins or natural rubbers—part of the class 520 series				209		1.204
514 501	Drug, bio-affecting and body treating compositions Compositions: ceramic		2,360	196 13		1.199 0.876	
			215		19		1.201
363	Electric power conversion systems	130	206	8	18	0.589	1.188
162	Paper making and fiber liberation	163	208	16	18	0.939	1.176
502	Catalyst, solid sorbent, or support therefor: product	425	302	20	26	0.450	1.170
310	Electrical generator or motor structure	307	386	36 42	33	1.122	1.162
210	Liquid purification or separation	452	782	43	66	0.911	1.147
137	Fluid handling	531	427	56	36	1.009	1.146
060	Power plants	380	547	44	46	1.108	1.143
118	Coating apparatus	208	288	26	24	1.196	1.133
015	Brushing, scrubbing, and general cleaning	135	229	21	19	1.489	1.128
280	Land vehicles	285	581	32	48	1.075	1.123
427	Coating processes	555	691	62	57	1.069	1.121
219	Electric heating	627	527	45	43	0.687	1.109
536	Organic compounds—part of the class 532–570 series	95	320	15	26	1.511	1.105

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in 1995.

Appendix table 6-16.

Patent classes most emphasized by inventors from Taiwan patenting in the United States: 1985 and 1995

Patent class number and title 1985 1995 1985 1995 437 Semiconductor device manufacturing: process 380 1,362 0 152 0 345 Selective visual display systems 159 356 0 10 0 074 Machine element or mechanism 365 290 0 8 0 297 Chairs and seats 154 223 0 6 0 313 Electric lamp and discharge devices 221 282 0 6 0 257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	Activity index 985 1995 .000 15.159 .000 3.816 .000 3.747 .000 2.890 .000 2.804 .000 2.470 .000 2.342 .000 2.200
437 Semiconductor device manufacturing: process 380 1,362 0 152 0 345 Selective visual display systems 159 356 0 10 0 074 Machine element or mechanism 365 290 0 8 0 297 Chairs and seats 154 223 0 6 0 313 Electric lamp and discharge devices 221 282 0 6 0 257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	000 15.159 000 3.816 000 3.747 000 3.655 000 2.890 000 2.804 000 2.600 000 2.470 000 2.342 000 2.200
345 Selective visual display systems 159 356 0 10 0. 074 Machine element or mechanism 365 290 0 8 0. 297 Chairs and seats 154 223 0 6 0. 313 Electric lamp and discharge devices 221 282 0 6 0. 257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0. 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0. 362 Illumination 171 330 0 6 0.	.000 3.816 .000 3.747 .000 3.655 .000 2.890 .000 2.804 .000 2.600 .000 2.470 .000 2.342 .000 2.200
074 Machine element or mechanism 365 290 0 8 0 297 Chairs and seats 154 223 0 6 0 313 Electric lamp and discharge devices 221 282 0 6 0 257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	.000 3.747 .000 3.655 .000 2.890 .000 2.804 .000 2.600 .000 2.470 .000 2.342 .000 2.200
074 Machine element or mechanism 365 290 0 8 0 297 Chairs and seats 154 223 0 6 0 313 Electric lamp and discharge devices 221 282 0 6 0 257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	.000 3.655 .000 2.890 .000 2.804 .000 2.600 .000 2.470 .000 2.342 .000 2.200
297 Chairs and seats 154 223 0 6 0 313 Electric lamp and discharge devices 221 282 0 6 0 257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	.000 2.890 .000 2.804 .000 2.600 .000 2.470 .000 2.342 .000 2.200
313 Electric lamp and discharge devices 221 282 0 6 0 257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	.000 2.890 .000 2.804 .000 2.600 .000 2.470 .000 2.342 .000 2.200
257 Active solid-state devices (e.g., transistors, solid-state diodes) 294 1,308 0 27 0 327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	.000 2.804 .000 2.600 .000 2.470 .000 2.342 .000 2.200
327 Miscellaneous active electrical nonlinear devices 302 627 0 12 0 362 Illumination 171 330 0 6 0	.000 2.600 .000 2.470 .000 2.342 .000 2.200
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330 Amplifiers	.000 1.127
372 Coherent light generators	.000 1.120
271 Sheet feeding or delivering	.000 1.100
429 Chemistry: electrical current producing apparatus,	
product, and process	.000 1.053
423 Chemistry of inorganic compounds	.917 1.045
205 Electrolysis: processes, compositions used therein	.000 1.021
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528 Synthetic resins or natural rubbers—part of the class 520 series 411 531 0 3 0.	.000 0.767

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in 1995.

Appendix table 6-17.

Patent classes most emphasized by inventors from South Korea patenting in the United States: 1985 and 1995

		Paten	ts granted t	o inventors	from:		
			untries		Korea	Activit	y index
Pater	nt class number and title	1985	1995	1985	1995	1985	1995
313	Electric lamp and discharge devices	221	282	0	27	0.000	7.550
437	Semiconductor device manufacturing: process	380	1,362	0	123	0.000	7.122
348	Television	569	1,028	0	85	0.000	6.520
358	Facsimile or television recording	248	629	0	42	0.000	5.266
369	Dynamic information storage or retrieval	277	658	0	39	0.000	4.674
360	Dynamic magnetic information storage or retrieval	476	789	0	46	0.000	4.598
365	Static information storage and retrieval	228	897	0	44	0.000	3.868
242	Winding, tensioning, or guiding	367	310	0	13	0.000	3.307
219	Electric heating	627	527	0	22	0.000	3.292
371	Error detection/correction and fault detection/recovery	142	431	0	16	0.000	2.927
315	Electric lamp and discharge devices: systems	236	332	0	12	0.000	2.850
318	Electricity: motive power systems	361	371	0	13	0.000	2.763
381	Electrical audio signal processing systems and devices	141	217	0	7	0.000	2.544
257	Active solid-state devices (e.g., transistors, solid-state diodes)	294	1,308	0	38	0.000	2.291
341	Coded data generation or conversion	170	280	0	8	0.000	2.253
015	Brushing, scrubbing, and general cleaning	135	229	0	6	0.000	2.066
062	Refrigeration	423	515	0	13	0.000	1.991
340	Communications: electrical	381	598	0	15	0.000	1.978
327	Miscellaneous active electrical nonlinear devices	302	627	0	15	0.000	1.887
501	Compositions: ceramic	142	215	0	5	0.000	1.834
326	Electronic digital logic circuitry	115	333	0	7	0.000	1.658
400	Typewriting machines	212	206	0	4	0.000	1.531
528	Synthetic resins or natural rubbers—part of the class 520 series	411	531	1	10	8.178	1.485
355	Photocopying	422	753	0	14	0.000	1.466
084	Music	101	220	0	4	0.000	1.434
548	Organic compounds—part of the class 532-570 series	212	281	0	5	0.000	1.403
359	Optics: systems (including communication) and element	549	1,083	0	19	0.000	1.383
280	Land vehicles	285	581	0	9	0.000	1.222
380	Cryptography	47	204	0	3	0.000	1.160
347	Incremental printing of symbolic information	320	486	0	7	0.000	1.136
523	Synthetic resins or natural rubbers—part of the class 520 series	277	210	0	3	0.000	1.127
148	Metal treatment	225	352	0	5	0.000	1.120
345	Selective visual display systems	159	356	0	5	0.000	1.108
375	Pulse or digital communications	177	573	0	8	0.000	1.100
427	Coating processes	555	691	0	9	0.000	1.027
156	Adhesive bonding and miscellaneous chemical manufacture	546	779	0	10	0.000	1.027
524	Synthetic resins or natural rubbers—part of the class 520 series	664	775 725	0	9	0.000	0.979
372		127	364	0	4	0.000	0.867
	Coherent light generators	463	763	0	8		0.827
361 333	Electricity: electrical systems and devices	463 167	213	0		0.000 0.000	0.740
					2		
134	Cleaning and liquid contact with solids	84	224	0	2	0.000	0.704
546	Organic compounds—part of the class 532-570 series	209	232	0	2	0.000	0.680
549	Organic compounds—part of the class 532-570 series	214	235	0	2	0.000	0.671
354	Photography	355	471	0	4	0.000	0.670
364	Electrical computers and data processing systems	695	1,529	0	13	0.000	0.670
239	Fluid sprinkling, spraying, and diffusing	230	240	0	2	0.000	0.657
330	Amplifiers	247	241	0	2	0.000	0.654
525	Synthetic resins or natural rubbers—part of the class 520 series	551	726	0	6	0.000	0.652
271	Sheet feeding or delivering	174	247	0	2	0.000	0.639
422	Chemical apparatus and process disinfecting, deodorizing,	011	500	_		0.000	0.000
050	preserving, or sterilizing	211	526	0	4	0.000	0.600
356	Optics: measuring and testing	340	669	0	5	0.000	0.589
455	Telecommunications	158	403	0	3	0.000	0.587

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in

Appendix table 6-18. Patents granted in selected countries, by inventor residence: 1985-95

						Percentag	Percentage of patents granted to residents of:	granted to re	esidents of:			
	Total	Patents to non- residents as	United				United				Former Soviet	
Granting country	patents	percentage of total	States	Japan	Germany	France	Kingdom	Italy	Sweden	India	Union	Other
					1985	35						
Japan	50,100	15.5	46.4	0.0	19.6	6.4	5.4	1.5	2.3	0.0	1.4	17.0
Germany	33,377	60.4	29.5	23.9	0.0	12.4	6.7	2.8	2.8	0.0	1.7	20.5
France	37,530	73.8	27.4	15.8	25.9	0.0	5.9	4.1	2.4	0.0	1.3	17.0
United Kingdom	34,480	82.3	28.6	20.8	20.9	8.4	0.0	2.9	2.2	0.0	9.0	15.6
Italy	47,924	79.0	6.1	2.3	8.0	4.2	2.0	0.0	0.4	0.0	0.0	77.0
Canada	18,697	92.8	54.8	11.7	8.8	5.6	5.3	1.5	1.8	0.0	0.4	10.0
Mexico	1,374	93.4	56.3	9.9	7.6	7.0	4.0	2.6	1.5	0.0	0.5	14.0
Brazil	3,934	84.6	37.0	7.3	20.7	6.6	4.0	4.6	2.8	0.0	0.4	13.3
South Korea	2,268	84.6	30.4	42.3	6.2	5.4	3.5	1.8	4.1	0.0	0.0	9.1
Soviet Union	74,745	2.0	13.7	8.4	16.9	8.2	3.1	3.9	2.7	0.0	0.0	42.9
India	1,814	76.2	33.5	6.4	11.2	8.1	10.1	3.4	1.3	0.0	3.0	23.0
					1990	06						
Japan	59,401	15.2	45.5	0.0	21.3	7.7	5.1	2.4	2.4	0.0	1.	14.4
Germany	42,860	61.2	27.8	28.4	0.0	10.8	6.5	3.7	2.7	0.0	0.7	19.3
France	35,149	74.6	24.9	18.2	26.9	0.0	0.9	4.2	2.2	0.0	9.0	17.0
United Kingdom	32,179	86.4	25.6	20.8	22.8	9.1	0:0	3.2	2.0	0.0	0.4	15.9
Italy	17,794	98.7	23.7	9.4	28.5	12.4	8.9	0.0	2.4	0.0	0.1	16.7
Canada	14,187	92.2	52.2	13.7	8.3	0.9	5.4	2.0	1.8	0.0	0.3	10.3
Mexico	1,752	92.0	63.4	5.4	7.3	5.1	3.2	2.4	0.8	0.1	0.2	12.2
Brazil	3,355	86.5	41.4	9.9	16.1	9.4	7.4	4.4	2.3	0.0	0.7	11.8
South Korea	7,762	67.1	23.0	2.99	2.5	1.8	8.0	Ξ	0.3	0.0	0.0	3.8
Soviet Union	84,658	4.1	12.0	8.1	18.8	7.8	3.6	6.7	3.8	0.0	0.0	39.2
India	1,611	81.0	35.3	9.3	14.6	6.2	7.8	3.1	1.2	0.0	3.4	19.1
					1994	94						
Japan	82,400	11.7	50.1	0.0	18.9	6.5	4.1	2.5	1.8	0.0	0.0	16.3
Germany	57,803	64.1	28.2	32.5	0.0	9.8	5.9	4.0	2.0	0.0	0.0	17.4
France	54,964	75.3	25.0	23.5	25.5	0.0	5.3	3.9	1.6	0.0	0.0	15.2
United Kingdom	48,772	89.3	24.9	25.7	22.0	8.0	0.0	3.3	1.5	0.0	0.0	14.5
Italy	37,096	85.5	24.8	13.4	27.6	10.2	5.9	0.0	1.9	0.0	0.1	16.1
Canada	11,641	92.7	51.3	18.8	9.7	5.6	4.6	1.5	1.0	0.0	0.0	9.2
Mexico	4,367	93.4	58.0	4.3	9.7	5.1	4.3	2.4	[:	0.0	0:0	14.9
Brazil	2,469	83.0	41.3	9.9	12.5	6.9	4.9	6.4	2.7	0.0	0.0	18.7
South Korea	11,683	9.05	22.9	62.6	3.9	2.5	1.1	0.8	0.5	0.0	0.0	5.8
Russian Federation	20,581	22.0	4.0	2.1	4.7	. .	0.8	1.5	9.0	0.0	0.0	85.2
India	1,735	74.2	42.9	6.1	12.4	7.1	9.9	5.6	1.6	0.0	0.2	20.4
0 30 4 00 00												

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Appendix table 6-18. Patents granted in selected countries, by inventor residence: 1985-95

						Percentaç	Percentage of patents granted to residents of	ranted to re	sidents of:			
	Total	Patents to non-	Linited				Linited				Former	
Granting country	patents	per	States	Japan	Germany	France	Kingdom	Italy	Sweden	India	Union	Other
					190	1995						
Japan	109,100	13.1	AA	NA	ΑN	AN	AN	N A	AN	NA	AN	ĄN
Germany	56,633	65.2	Ϋ́	Ϋ́	Ϋ́	Ϋ́	ΑN	ΑĀ	NA	N A	Ϋ́	Ϋ́
France	. 55,681	72.5	Ϋ́	Ϋ́	Ϋ́	Ϋ́Z	ΑN	Ą	Ν	Ν Α	Ą	Ϋ́
United Kingdom	48,350	89.2	Ϋ́	Ϋ́Z	Ϋ́	Ϋ́	Ϋ́	ΑĀ	Ν Α	Ν Α	Ϋ́	Ϋ́
Italy	29,898	7.76	Ϋ́	Ϋ́Z	Ϋ́	Ϋ́	ΑN	ΑĀ	NA	ΑN	Ϋ́	Ϋ́
Canada	9,139	91.9	Ϋ́	Ϋ́Z	Ϋ́	Ϋ́	ΑN	Ν	AN	Ϋ́	Ϋ́	Ϋ́
Mexico	3,538	95.8	Ϋ́	Ϋ́Z	Ϋ́	Ϋ́Z	NA	۷Z	Ϋ́	ΑN	Ϋ́	Ϋ́
Brazil	2,659	80.3	Ϋ́	Ϋ́	Ϋ́	Ϋ́	ΑN	ΑĀ	NA	N A	Ϋ́	Ϋ́
South Korea	12,512	47.5	Ϋ́	Ϋ́	Ϋ́	Ϋ́	ΑN	Ν	AN	Ν Α	Ϋ́	Ϋ́
Russian Federation	25,633	18.6	Ϋ́	Ϋ́	Ϋ́	Ϋ́	ΑN	ΑĀ	A	N A	Ϋ́	ΑN
India	1,613	74.3	Ą	Ϋ́	Ϋ́	N	Y Y	Ą	Y Y	ΑĀ	Ϋ́	٩Z

NA = not available

NOTE: German data are for the former West Germany only.

SOURCE: World Intellectual Property Organization, "Industrial Property Statistics" (Geneva: 1985-95).

See figures 6-18 and 6-19.

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Appendix table 6-19. Venture capital under management in the United States and disbursements: 1969-95

(Millions of U.S. dollars)

	lew capital	Total venture capital under management	Disbursements
1969	121	NA	100
1970	78	NA	83
1971	91	NA	134
1972	30	NA	128
1973	33	NA	201
1974	25	NA	100
1975	20	NA	92
1976	28	NA	107
1977	15	NA	159
1978	216	NA	288
1979	170	NA	457
1980	661	NA	608
1981	867	NA	1,155
1982	1,400	NA	1,454
1983	3,400	6,208	2,581
1984	3,200	9,497	2,771
1985	2,300	11,614	2,681
1986	3,300	14,693	3,242
1987	4,200	17,799	3,977
1988	2,947	20,217	3,847
1989	2,399	23,154	3,395
1990	1,847	24,139	1,922
1991	1,271	24,758	1,348
1992	2,548	25,868	2,540
1993	2,545	28,925	3,071
1994	3,765	32,670	2,741
1995	4,227	37,154	3,859

NA = not available

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

See figure 6-23.

Appendix table 6-20. Capital commitments by limited partners to institutionally funded independent private venture capital funds: 1978-95 (Millions of U.S. dollars)

	Total	Corporations	Endowments & foundations	Foreign investors	Individuals & families	Insurance companies	Pension funds
1978	216	22	19	38	70	35	32
1979	170	28	17	26	39	7	53
1980	661	127	92	55	102	88	197
1981	867	142	102	90	201	132	200
1982	1,423	175	96	188	290	200	474
1983	3,408	415	267	531	715	410	1,070
1984	3,185	463	178	573	467	419	1,085
1985	2,327	274	181	548	303	254	767
1986	3,332	350	209	361	392	348	1,672
1987	4,184	460	418	544	502	628	1,632
1988	2,947	324	341	401	249	277	1,355
1989	2,399	483	296	299	146	303	872
1990	1,847	125	232	138	211	171	970
1991	1,271	55	306	149	156	69	536
1992	2,548	84	471	283	280	370	1,060
1993	2,545	206	271	109	187	268	1,504
1994	3,765	341	805	91	444	357	1,727
1995	4,227	87	959	NA	741	784	1,656

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

Appendix table 6-21. U.S. venture capital disbursements, by industry category: 1986-95

Industry category	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
		Milli	ons of U.S. c	Millions of U.S. dollars disbursed	rsed					
Commercial communications	145	171	105	146	80	20	53	134	46	191
Telephone and data communications	346	306	369	342	268	169	366	384	294	399
Computer hardware and systems	220	523	422	354	259	168	138	86	171	183
Software and services	353	417	338	379	362	337	562	630	378	200
Other electronics	386	361	319	300	147	129	140	86	167	141
Biotechnology	183	265	322	245	181	112	261	283	303	205
Medical/health care related	335	481	451	522	380	152	442	437	473	547
Energy related	23	53	15	18	22	က	30	7	2	က
Industrial automation	73	22	31	28	16	က	7	30	16	26
Industrial products and machinery	118	183	198	192	77	47	77	54	26	125
Consumer related	285	642	425	392	225	135	196	314	173	405
Other products and services	445	520	852	477	284	83	271	613	663	874
Total	3,242	3,977	3,847	3,395	2,301	1,358	2,543	3,071	2,741	3,859
		Percentage (of total ventu	ıre capital di	of total venture capital disbursements					
Commercial communications	4	4	က	4	က	2	2	4	2	2
Felephone and data communications	10	∞	6	10	12	12	14	13	-	10
Computer hardware and systems	17	13	=======================================	10	1	12	2	ဇ	9	2
Software and services	7	1	6	=======================================	16	25	22	21	14	20
Other electronics	12	o	80	6	9	တ	9	က	9	4
Biotechnology	9	7	80	7	∞	∞	10	6	=======================================	2
Medical/health care related	10	12	12	15	17	1	17	14	17	4
Energy related	-	-	-	-	-	-	-	∇	7	7
Industrial automation	2	-	-	-	-	-	-	-	√	7
Industrial products and machinery	4	2	2	9	က	က	က	7	7	က
Consumer related	တ	16	1	12	10	10	80	10	9	1
Other products and services	14	13	22	41	12	9	7	20	24	23
Total	100	100	100	100	100	100	100	100	100	100

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

See figure 6-24.

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Appendix table 6-22. U.S. venture capital disbursements, by stage: 1986-95

Stage	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
		ı	Millions of	U.S. dollar	s disburse	d				
Seed	101	87	114	138	72	56	74	213	116	232
Startup	526	452	349	288	170	76	209	217	408	663
Other early stage	509	603	585	537	391	295	336	319	481	580
Expansion	1,416	1,773	1,510	1,596	1,194	734	1,400	1,668	1,232	1,614
Leveraged buyout/acquisition	601	804	1,127	710	414	46	176	172	166	338
Other	89	258	162	126	60	151	347	481	339	432
Total disbursements	3,242	3,977	3,847	3,395	2,301	1,358	2,542	3,070	2,741	3,859
		Percenta	ge of total	venture ca	pital disbu	rsements				
Seed	3	2	3	4	3	4	3	7	4	6
Startup	16	11	9	8	7	6	8	7	15	17
Other early stage	16	15	15	16	17	22	13	10	18	15
Expansion	44	45	40	47	52	54	55	54	45	42
Leveraged buyout/acquisition	18	20	29	21	18	3	7	6	0	9
Other	3	7	4	4	3	11	14	16	12	11
Total	100	100	100	100	100	100	100	100	100	100

NOTE: Details may not sum to totals because of rounding.

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

See figure 6-25.

Appendix table 6-23. **Leading indicators of technological competitiveness: 1996** (Index)

Region/country	National orientation	Socioeconomic infrastructure	Technological infrastructure	Productive capacity
Singapore	88.4	75.7	41.6	54.0
South Korea	78.9	64.6	44.4	50.6
Taiwan	90.2	75.8	42.9	49.9
China	65.3	44.8	39.3	32.8
India	57.4	46.0	39.3	49.1
Indonesia	54.8	35.2	17.8	19.6
Malaysia	81.0	62.5	31.9	43.1
Philippines	73.6	66.2	35.3	48.1
Thailand	63.5	48.7	28.2	33.1
Hungary	67.0	47.7	36.4	39.8
Poland	69.7	57.4	38.1	39.8
Russia	48.9	50.7	55.6	42.6
Argentina	41.5	49.4	27.4	31.0
Brazil	60.0	53.1	37.4	40.3
Mexico	54.8	45.5	30.2	31.7
Venezuela	56.6	55.2	38.4	40.7
South Africa	49.2	51.0	40.3	30.0

NOTES: For score and indicator calculations, raw data were transformed into scales of 0-100 for each indicator component and then averaged to generate comparable indicators with a 0-100 range. For survey items, 100 represents the highest response category for each question; for statistical data, 100 typically represents the value attained by the country with the largest value among the 30 countries included in the study. In the indicator formulations cited below, each term carries equal weight.

National orientation (NO)—evidence that a nation is taking directed action to achieve technological competitiveness. These actions could take place in the business, government, or cultural sector, or any combination of the three.

Indicator formulation: NO = Q1 + (Q2 + Q3)/2 + Q4 + F1V96

Data used: Published data from Frost and Sullivan's "Political Risk Letter" for 1996 rating each country's investment risk (F1V96); and survey data assessing each country's national strategy to promote high-tech development (Q1), social influences favoring technological change (Q2 and Q3), and entrepreneurial spirit (Q4).

Socioeconomic infrastructure (SE)—assesses the social and economic institutions that support and maintain the physical, human, organizational, and economic resources essential to the functioning of a modern, technology-based industrial nation.

Indicator formulation: SE = Q5 + Q10 + HMHS93

Data used: Published data on the percentage of students enrolled in secondary and tertiary education (HMHS93) from the Harbison-Myers Skills Index for 1993; and survey data assessing each country's efforts to attract foreign investment (Q10) and the mobility of capital (Q5).

Technological infrastructure (TI)—assesses the institutions and resources that contribute to a nation's capacity to develop, produce, and market new technology.

Indicator formulation: TI = (Q7 + Q8)/2 + Q9 + Q11 + EDP96 + S&E

Data used: Published data from UN Statistical Yearbook on the number of scientists and engineers involved in research (S&E), national purchases of electronic data processing equipment (EDP96) from Elsevier Yearbook of World Electronics Data (1996); and survey data assessing linkages of R&D to industry (Q9), output of indigenous academic science and engineering (Q7and Q8), and ability to make effective use of technological knowledge (Q11).

Productive capacity (PC)—assesses the phsical and human resources devoted to manufacturing products and the efficiency with which those resources are employed.

Indicator formulation: PC = Q6 + Q12 + Q13 + A2696

Data used: Published data on electronics production (A2696) from Elsevier Yearbook of World Electronics Data (1996); and survey data assessing the supply and quality of skilled labor (Q6), capability of the indigenous management (Q13), and the existence of indigenous suppliers of components for technology-intensive products (Q12).

SOURCE: J. David Roessner, Alan L. Porter, Nils Newman, and Honguang Xu, 1996 Indicators of Technology-Based Competitiveness of Nations, Summary Report, report to the National Science Foundation under Purchase Order No. D22588X-00-0 (Atlanta: Georgia Institute of Technology, 1997).

See figure 6-27.

Appendix table 7-1.
Indices of issue interest: 1979-97
(Mean index scores)

Issue	1979	1981	1983	1985	1988	1990	1992	1995	1997
Foreign policy	49	59	54	59	58	89	62	48	47
New scientific discoveries	61	09	89	99	99	63	61	29	70
New technologies	29	28	65	64	64	64	64	99	69
Space exploration	ı	47	20	52	26	20	47	20	22
Energy/nuclear power ^a	29	20	62	61	61	64	22	54	54
Medical discoveries	ı	1	ı	83	82	83	82	83	83
Environmental issues	ı	1	1	1	ı	80	77	74	72
Economic policy	59	71	74	69	69	20	74	89	89
Sample size	1,635	3,195	1,631	2,005	2,041	2,033	2,001	2,006	2,000

- = not asked

NOTES: Each index is a summary measure of respondent reports that they are "very interested," "moderately interested," or "not at all interested" in each specific issue. Responses are to the statement: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested." The original responses were converted to a 0-100 index by assigning a value of 100 for a "very interested" response and a value of 50 for a "moderately interested" response.

aln 1990, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear energy policy." In 1988, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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See figure 7-1.

Appendix table 7-2. **Public interest in selected issues: 1979-97**(Percentages)

		1979			1981		-	1983		-	1985		-	1988		~	1990		19	1992		196	1995		1997	97	ı
Issue	=	VI MI NI MI NI	Ξ	=	≅	Į≥		≅	 Z		₹	≅		Ī	-	-	_	> Z	2	Z	> =	Σ	\ <u>\</u>	>	≥	Z	
Foreign policy	22	22 53 24 35 47 18	24	35	47	9	8	47						50 1		48 4	40					21 53	l	6 22	50		۔۔ ا
New scientific discoveries	36	49	4	37	45	17	48	40	=			12	43	46 1		39 4	48 1	12 36	6 49		15 4	4 4		11 49	9 42		
New technologies	33	51	15	33	20	16	45	45	12	39	. 49	12		48	12			12 37								3 10	_
Space exploration	ı	ı	ı	25	4	સ	27	45					34				48							26 3,			٠.
Energy/nuclear power ^a	46	42	Ξ	20	40	우	39	46	4	36	. 09	5	38	46		42 4		14 32			18 29	29 49		1 29			_
Medical discoveries	ı	ı	ı	ı	ı	ı	ı	ı	ı												39			4 7(
Environmental issues	ı	ı	ı	ı	ı	ı	ı	ı	1	ı	1	1	1		ı						5 5						
Economic policy	32	48	17	25	37	9	22	33	9	48	4	Ξ	48	42	10		40	10 56	98 39		8		42 1	11	7 42		
Sample size		1,635		-,	3,195		-	,631		7	,000		2,	2,041		2,(,033		2,0	0		2,0(90		2,0	8	

VI = very interested; MI = moderately interested; NI = not at all interested; -= not asked

NOTES: Responses are to the statement: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested." "Don't know" responses are not included. Percentages may not total 100 because of rounding.

and 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-3. **Mean score on indices of interest in scientific and technological issues, by sex and level of education: 1997** (Mean index scores)

Sex and level of education	New scientific discoveries	New technologies	Medical discoveries	Space exploration	Nuclear energy	Environmental issues	Sample size
All adults	70	69	83	55	54	72	2,000
Sex							
Male	71	73	81	63	55	70	930
Female	70	65	86	49	54	75	1,070
Formal education							
Less than high school	61	56	79	42	54	70	420
High school graduate	70	70	85	56	53	73	1,188
Baccalaureate degree	78	75	86	66	58	74	257
Graduate/professional degree	84	80	87	67	62	79	135
Science/mathematics education ^a							
Low	64	62	83	48	51	71	1,112
Middle	75	73	85	58	57	74	509
High	84	81	85	72	61	74	379

NOTES: Each index is a summary measure of respondent reports that they are "very interested," "moderately interested," or "not at all interested" in each specific issue. A value of 100 was assigned to a "very interested" response, and a value of 50 was assigned to a "moderately interested" response.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-2.

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

Appendix table 7-4.
Indices of issue informedness: 1979-97
(Mean index scores)

Issue	1979	1981	1983	1985	1988	1990	1992	1995	1997
Foreign policy	35	44	40	42	42	51	46	36	36
New scientific discoveries	36	38	40	43	42	42	39	42	49
New technologies	35	35	42	39	38	38	38	40	44
Space exploration	ı	37	39	42	39	37	33	33	41
Energy/nuclear powera	47	51	47	44	37	37	32	29	31
Medical discoveries	ı	ı	ı	53	52	53	51	52	56
Environmental issues	ı	ı	ı	ı	ı	09	22	52	51
Economic policy	42	55	54	48	20	53	56	52	51
Sample size	1,635	3,195	1,631	2,005	2,041	2,033	2,001	2,006	2,000

- = not asked

NOTES: Each index is a summary measure of respondent reports that they are "very well-informed," "moderately well-informed," or "poorly informed," about each specific issue. Responses are to the statement: "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed, or poorly informed." The original responses were converted to a 0-100 index by assigning a value of 100 for a "very well-informed" response and a value of 50 for a "moderately well-informed" response.

aln 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear energy policy." In 1988, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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See figure 7-3.

Appendix table 7-5. **Public informedness on selected issues: 1979-97**(Percentages)

		1979			1981		-	1983			1985		-	1988		130	1990		19	1992		1995)5		1997	
lssue	>	N IM N IN IN	Z	=	₹	Ξ	>	≅	Į	5	≅	Ξ		Σ	₹	 	<u> </u>	> Z	2	=	>	Σ	 	>	₹	Z
Foreign policy	ω	54	37	17	54 37 17 54	78	14	51	35	15	53	32					2 29		9 54) 52		10) 52	38
New scientific discoveries	10	52	37	13	49	88	13	23	34	13	29					14 5		31 12	54	34		13 58		19		23
New technologies	10	20	33	F	48	40	14	22	32	12	54	34	12	51	. 98		53						33			
Space exploration	1	ı	ı	14	46	40	13	25	34	16	52					11 5								16		
Energy/nuclear power ^a	18	28	23	23	26	21	19	26	24	16	55					12 5	50	10			9) 51			
Medical discoveries	ı	ı	ı	ı	ı	ı	ı	ı	ı	24	22	8			19											
Environmental issues	ı	ı	ı	ı	ı	ı	ı	ı	ı		ı					32 5				3 15						
Economic policy	4	22	31	59	21	20	28	25	20	22	21	56	22	22	22 ;		25		9 54			5 53	3 22		5 51	
Sample size		1,635		•	3,195		_	,631		· · ·	2,005		Ω	2,041		2,(2,033		2,0	10		2,00	90		2,00	0

VI = very well-informed; MI = moderately well-informed; NI = poorly informed; - = not asked

NOTES: Responses are to the statement: "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed, or poorly informed." "Don't know" responses are not included. Percentages may not total 100 because of rounding.

and 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-6.

Mean score on indices of informedness on scientific and technological issues, by sex and level of education: 1997 (Mean index scores)

Sex and level of education	New scientific discoveries	New technologies	Medical discoveries	Space exploration	Nuclear energy	Environmental issues	Sample size
All adults	49	44	56	41	31	51	2,000
Sex							
Male	51	47	52	49	33	52	930
Female	47	41	60	34	28	50	1,070
Formal education							
Less than high school	45	42	58	36	38	54	420
High school graduate	47	43	55	41	28	49	1,188
Baccalaureate degree	55	49	57	46	29	52	257
Graduate/professional degree	60	54	61	50	34	58	135
Science/mathematics education ^a							
Low	44	41	56	37	30	50	1,112
Middle	48	45	54	43	30	53	509
High	63	54	61	53	32	53	379

NOTES: Each index is a summary measure of respondent reports that they are "very well-informed," "moderately well-informed," or "poorly informed" about each specific issue. A value of 100 was assigned to a "very well-informed" response, and a value of 50 was assigned to a "moderately well-informed" response.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-2.

aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

Appendix table 7-7. **Public attentiveness to selected issues: 1979-97**(Percentages)

Issue	1979	1981	1983	1985	1988	1990	1992	1995	1997
Foreign policy									
Attentive public	6	6	8	8	8	14	11	5	5
Interested public	16	29	23	25	25	34	27	16	18
Residual public	78	65	70	67	67	52	62	79	77
New scientific discoveries									
Attentive public	7	9	9	8	8	8	7	7	11
Interested public	29	28	40	36	34	31	29	37	38
Residual public	64	63	52	56	57	61	64	56	51
New inventions & technologies									
Attentive public	6	8	8	8	7	7	6	6	9
Interested public	27	26	34	31	33	32	30	37	38
Residual public	67	67	58	61	60	61	63	57	53
Science and technology policy ^a									
Attentive public	9	12	13	12	11	11	10	10	14
Interested public	37	35	48	44	42	40	40	47	46
Residual public	54	54	39	45	46	49	50	43	40
Space exploration									
Attentive public	_	7	7	9	8	6	5	5	8
Interested public	_	18	20	20	26	20	17	20	24
Residual public	_	75	73	71	66	74	78	75	68
Energy/nuclear power ^b									-
Attentive public	_	_	15	9	8	8	6	4	4
Interested public	_	_	25	28	30	34	26	25	25
Residual public	_	_	61	63	62	58	68	71	71
Medical discoveries			•		0 2				• •
Attentive public	_	_	_	17	16	16	17	15	19
Interested public	_	_	_	51	56	52	49	53	52
Residual public	_	_	_	32	28	32	34	31	29
Environmental issues				0_			٠.	•	
Attentive public	_	_	_	_	_	20	18	13	12
Interested public	_	_	_	_	_	43	41	40	40
Residual public	_	_	_	_	_	36	41	48	48
Economic policy						00	• • •	.0	10
Attentive public	9	12	19	16	15	17	19	15	14
Interested public	26	40	38	32	33	34	38	32	32
Residual public	65	48	43	52	52	50	44	53	54
riosiduai publio	00	70	70	<i>52</i>	52	50	77	50	54
Sample size	1,635	3,195	1,631	2,005	2,041	2,033	2,001	2,006	2,000

⁻⁼ not asked

NOTES: Responses are to the statements: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested"; "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed, or poorly informed"; and "Now let me change the topic slightly and ask you how you get information. First, how often do you read a newspaper: every day, a few times a week, once a week, or less than once a week? Are there any magazines that you read regularly, that is, most of the time? What magazine would that be? Is there another magazine that you read regularly? What magazine would that be?" Percentages may not total 100 because of rounding.

To be classified as attentive to a given issue area, respondents must indicate that they are "very interested" in that area, that they are "very well-informed" about it, and that they regularly read a daily newspaper or relevant national magazine. Citizens who report that they are "very interested" in an issue area, but who do not think that they are "very well-informed" about it, are classified as the "interested public." All other individuals are classified as members of the "residual public" for that issue area.

^aThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

bln 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about energy policy." In 1988, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-4.

Public attentiveness to scientific and technological issues, by sex and level of education: 1997 Appendix table 7-8 (Percentages)

Sex and level of education AP All adults	discoveries	New technologies	gies	Science and technology policy ^a	and policyª	Medical discoveries	al ries	Space exploration	tion	Nuclear	ar IV	Environmenta issues	nental ss	
All adults11	₾	АР		АР	۵	АР	≗	AP	≗	АР	≗	AP	₾	Sample size
Sex	38	o	38	14	46	19	52	8	24	4	25	12	40	2,000
Male 12	39	Ξ	43	16	49	15	51	14	28	2	24	14	35	930
Female9 Formal education	38	7	34	13	43	23	53	4	20	ო	26	Ξ	45	1,070
Less than high school 9	32	တ	25	15	34	21	43	9	18	9	27	10	41	420
High school graduate	39	œ	40	12	49	16	26	œ	24	က	24	1	41	1,188
Baccalaureate degree 15 Graduate/professional	43	10	46	18	51	24	48	13	30	2	56	16	37	257
degree	47	22	14	30	49	24	51	16	25	∞	59	22	40	135
Low 7	34	9	33	10	42	18	51	9	19	က	24	Ξ	4	1,112
Middle 9	43	6	41	4	20	16	22	7	27	9	25	12	41	509
High 22	47	17	47	28	50	25	48	17	34	9	27	17	37	379

AP = attentive public; IP = interested public

week, or less than once a week? Are there any magazines that you read regularly, that is, most of the time? What magazine would that be? Is there another magazine that you read regularly? What magazine would NOTES: Responses are to the statements: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like moderately well-informed, or poorly informed"; and "Now let me change the topic slightly and ask you how you get information. First, how often do you read a newspaper: every day, a few times a week, once a you to tell me if you are very interested, moderately interested, or not at all interested": "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed,

ō To be classified as attentive to a given issue area, respondents must indicate that they are "very interested" in that area, that they are "very well-informed" about it, are classified as the "interested public." All other relevant national magazine. Citizens who report that they are "very interested public." All other individuals are classified as members of the "residual public" for that issue area. "The attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

PRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-5.

U.S. public understanding of scientific vocabulary and concepts, by selected characteristics: 1997 Appendix table 7-9. (Percentages)

Characteristic	∢	В	O	۵	ш	ш	Ø	I	_	7	ㅈ	_	Σ	z	0	۵	Ø	Œ	v	S ⊢	Sample size
All adults	82	71	84	62	39	44	43	32	78	44	93	51	59	75	73	48	22	1	13	1	2,000
Sex MaleFemale	89 76	80	88	54 69	56 24	53 36	36 49	39 26	86 71	50 38	94	53 49	67 53	88 64	85 64	58 40	26 18	17	16	16	930
Formal education Less than high school	22	55	77	4	25	25	20	25	29	38	91	37	44	61	51	29	∞	-	Ŋ	-	420
graduate	82	71	98	99	35	42	43	30	78	40	93	52	61	92	75	49	18	6	12	ნ	1,188
degree	88 6	88 6	89	72	62	99 7	64	£ 4	98 9	55	£ 6	09	69	48 0	98	62	84 0	28	52	21	257
Science/mathematics education ^a	06 92	Z 09	° °	57 75	0 0	2 6	- 88	9	30	o &	0 0	60 4 6 C4	0 75	0 2	_ _ &			o, «		§ 4	11.0
Middle High	86 93	78 94	91	64 77	40 70	49 79	47 67	30 45	80 80	64 64 64	95 96	58	61	89	81 93	56 77	25 56	12 36	12 27	3 1	509 379
Attentiveness to science and technology ⁶ Attentive public Interested public Residual public	89 85 75	86 75 61	88 84 82	61 66 58	56 43 27	56 49 33	49 47 36	45 34 25	87 81 71	63 46 35	94 93 92	59 54 45	66 64 52	78 78 70	85 76 64	66 51 39	36 25 13	21 14 5	23 4 8	23 11 6	288 918 794

NOTE: Understanding is determined by correct responses to the following statements:

boiling it." (False); N = "Which travels faster: light or sound?" (Light); O = "Does the earth go around the sun, or does the sun go around the earth?" (earth around the sun); P = "How long does it take for the earth to go around the sun: one day, one month, or one year?" (One year); Q = "Please tell me, in your own words, what is DNA?"; R = "Please tell me, in your own words, what is a molecule?"; S = "Please tell me, in your boy or a girl." (True); E = "Lasers work by focusing soundwaves." (False); F = "Electrons are smaller than atoms." (True); G = "Antibiotics kill viruses as well as bacteria." (False); H = "The universe began with a huge A = "The center of the earth is very hot." (True); B = "All radioactivity is man-made." (False); C = "The oxygen we breathe comes from plants." (True); D = "It is the father's gene which decides whether the baby is a explosion." (True); I = "The continents on which we live have been moving their location for millions of years and will continue to move in the future." (True); J = "Human beings, as we know them today, developed from earlier species of animals." (True); K = "Cigarette smoking causes lung cancer." (True); L = "The earliest humans lived at the same time as the dinosaurs." (False); M = "Radioactive milk can be made safe by own words, what is the Internet?"; T = "Please tell me, in your own words, what is radiation?

"PRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer. The attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology,

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-6.

Appendix table 7-10. Mean score on Index of Scientific Construct Understanding, by selected characteristics: 1997 (Mean index scores)

Characteristic	Mean score
All adults	55
Sex	
Male	62
Female	49
Formal education	
Less than high school	44
High school graduate	54
Baccalaureate degree	68
Graduate/professional degree	72
Science/mathematics education ^a	
Low	47
Middle	58
High	74
Attentiveness to science and technology ^b	
Attentive public	65
Interested public	58
Residual public	48

NOTE: The Index of Scientific Construct Understanding is a composite measure of the public understanding of scientific terms and concepts. In 1997, this measure included responses to the following true/false questions: "All radioactivity is man-made"; "Electrons are smaller than atoms"; "The earliest humans lived at the same time as the dinosaurs"; and "The continents on which we live have been moving their location for millions of years and will continue to move in the future." The following short-answer items were also included: "Which travels faster: light or sound?"; "Does the earth go around the sun, or does the sun go around the earth?"; and "How long does it take for the earth to go around the sun: one day, one month, or one year?" Coded verbatim responses to the following open-ended questions were also included: "Please tell me, in your own words, what is DNA?"; "Please tell me, in your own words, what is radiation?"

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Science & Engineering Indicators – 1998

Appendix table 7-11. **Public understanding of the nature of scientific inquiry, by selected characteristics: 1997** (Percentages)

Characteristic	Percentage
All adults	27
Sex	
Male	29
Female	25
Formal education	
Less than high school	8
High school graduate	27
Baccalaureate degree	46
Graduate/professional degree	54
Science/mathematics education ^a	
Low	16
Middle	30
High	55
Attentiveness to science and technology ^b	
Attentive public	35
Interested public	31
Residual public	20

NOTE: Responses are to the following questions: "Now, think about this situation. A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple's children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?" "Now, let me turn to a slightly different type of question. When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term 'scientific study,' do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means? (if clear understanding or general sense): In your own words, could you tell me what it means to study something scientifically?" "Now, please think about this situation. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many of them experience lower blood pressure. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?"

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-12. Mean score on Index of Scientific Construct Understanding in 14 industrialized nations: Most recent year

Country (year)	Mean index score	Sample size
United States (1997)	55	2,000
United States (1995)	55	2,000
United States (1990)	54	2,033
Denmark (1992)	55	1,000
The Netherlands (1992)	54	1,000
Great Britain (1992)	53	1,000
France (1992)	52	1,000
Germany (1992)	51	2,000
Belgium (1992)	49	1,000
Italy (1992)	47	1,000
Canada (1989)	46	2,000
Spain (1992)	45	1,000
Ireland (1992)	42	1,000
Greece (1992)	37	1,000
Japan (1991)	36	1,457
Portugal (1992)	33	1,000

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology*, 1979-1997, *Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); J.D. Miller, "Public Understanding of Science and Technology in OECD Countries: A Comparative Analysis," paper presented to the 1996 OECD Symposium on Public Understanding of Science and Technology, Tokyo; and J.D. Miller, R. Pardo, and F. Niwa, *Public Attitudes Toward Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Madrid: BBV Foundation, 1997).

See figure 7-10.

Appendix table 7-13. **General attitudes toward science and technology, by selected characteristics: 1992, 1995, and 1997** (Mean index scores)

		1992			1995			1997	
Characteristic	Pa	Rb	P/R	Pa	R⁵	P/R	Pª	R⁵	P/R
All adults	67	38	1.76	68	39	1.74	70	37	1.89
Sex									
Male	68	39	1.74	69	38	1.82	71	35	2.03
Female	67	38	1.76	67	40	1.68	69	39	1.77
Formal education									
Less than high school	64	49	1.31	63	51	1.24	69	45	1.53
High school graduate	67	39	1.72	68	39	1.74	69	38	1.82
Baccalaureate degree	70	27	2.59	71	29	2.45	74	28	2.64
Graduate/professional degree	71	24	2.96	73	24	3.04	75	24	3.13
Science/mathematics education ^c									
Low	66	43	1.53	67	44	1.52	69	42	1.64
Middle	67	38	1.76	69	35	1.97	71	34	2.09
High	71	24	2.96	71	28	2.54	75	27	2.78
Attentiveness to science and technology ^d									
Attentive public	71	36	1.97	74	30	2.47	75	30	2.50
Interested public	70	36	1.94	69	38	1.82	73	35	2.09
Residual public	65	41	1.59	65	42	1.55	66	43	1.54

P = Index of Scientific Promise; R = Index of Scientific Reservations; P/R = ratio of scores on the two indices

^aThe Index of Scientific Promise includes responses to the following statements: "Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree. If you feel especially strongly about a statement, please tell me that you strongly agree or strongly disagree. First, science and technology are making our lives healthier, easier, and more comfortable—do you strongly agree, agree, disagree, or strongly disagree? Most scientists want to work on things that will make life better for the average person—do you strongly agree, disagree, or strongly disagree? With the application of science and new technology, work will become more interesting—do you strongly agree, disagree, or strongly disagree? Because of science and technology, there will be more opportunities for the next generation—do you strongly agree, disagree, or strongly disagree?"

bThe Index of Scientific Reservations includes responses to the following statements: "Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree. If you feel especially strongly about a statement, please tell me that you strongly agree or strongly disagree. We depend too much on science and not enough on faith—do you strongly agree, agree, disagree, or strongly disagree? It is not important for me to know about science in my daily life—do you strongly agree, agree, disagree, or strongly disagree? Science makes our way of life change too fast—do you strongly agree, agree, disagree, or strongly disagree? Now for a different type of question. People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits? (if benefits greater): Would you say that the balance has been strongly in favor of beneficial results, or only slightly?"

Respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

^dThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-14.

Responses to items in the Index of Scientific Promise and the Index of Scientific Reservations: 1997 (Percentages)

Item	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
Index of Scientific Promise					
Science and technology are making our lives					
healthier, easier, and more comfortable	29	60	2	7	2
Most scientists want to work on things					
that will make life better for the average person	11	68	4	15	2
With the application of science and new technology,					
work will become more interesting	9	63	6	21	1
ű					
Because of science and technology, there will be					
more opportunities for the next generation	13	68	4	14	1
Index of Scientific Reservations					
We depend too much on science and not enough on faith	12	35	6	39	8
It is not important for me to know about science in my					
daily life	2	12	1	58	27
adily iiio	_		•	00	
Science makes our way of life change too fast	4	32	2	55	6
	B>>H	B>H	B=H	H>B	H>>B
Have the benefits of scientific research outweighed the					
harmful results or have the harmful results outweighed	4-7	00	40	•	
the benefits?	47	28	13	8	4

B>>H = benefits strongly outweigh the harmful results; B>H = benefits outweigh the harmful results; B=H = benefits equal the harmful results; H>B = harmful results outweigh the benefits; H>B = harmful results outweigh the benefits

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-15.

Responses to and mean scores on the Attitude Toward Organized Science Scale, by selected characteristics: 1983-97

Response and characteristic	1983	1985	1988	1990	1992	1995	1997
	Perce	ntage of the	public				
Agree that "science and technology are making							
our lives healthier easier, and more comfortable"	84	86	87	84	85	86	89
Agree that "the benefits of science are							
greater than any harmful effects"	57	68	76	72	73	72	75
Disagree that "science makes our way of life							
change too fast"	50	53	59	60	63	60	61
Disagree that "we depend too much on science							
and not enough on faith"	43	39	43	44	45	44	48
	Ме	an ATOSS so	ore				
All adults	2.3	2.5	2.7	2.6	2.7	2.6	2.7
Sex							
Male	2.2	2.4	2.6	2.5	2.7	2.7	2.9
Female	2.5	2.6	2.8	2.8	2.6	2.5	2.6
Formal education							
Less than high school	1.8	1.8	2.2	1.8	2.0	2.0	2.2
High school graduate	2.4	2.6	2.8	2.7	2.7	2.6	2.7
Baccalaureate degree	2.9	3.1	3.2	3.1	3.3	3.3	3.2
Graduate/professional degree	2.9	3.1	3.1	3.2	3.3	3.4	3.4
Science/mathematics education ^a							
Low	NA	NA	NA	2.4	2.5	2.3	2.5
Middle	NA	NA	NA	2.9	2.7	2.9	2.9
High	NA	NA	NA	3.3	3.3	3.2	3.3
Attentiveness to science and technology ^b							
Attentive public	2.6	2.8	3.0	2.8	2.9	3.1	3.0
Interested public	2.4	2.6	2.8	2.7	2.8	2.7	2.9
Residual public	2.1	2.3	2.5	2.5	2.5	2.4	2.4
Sample size	1,631	2,005	2,041	2,033	997	2,006	2,000

ATOSS = Attitude Toward Organized Science Scale; NA = not available

NOTES: Responses are to the following statement: "Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree. If you feel especially strongly about a statement, please tell me that you strongly agree or strongly disagree." The scale is a count of agreement with the first two items and disagreement with the second two items.

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated* Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-16. General attitudes toward science and technology in 14 industrialized nations: Most recent year (Mean index scores)

Country (year)	Index of Scientific Promise	Index of Scientific Reservation	Ratio of indices
United States (1997)	70	37	1.89
United States (1995)	68	39	1.74
United States (1992)	67	38	1.76
Canada (1989)	72	56	1.29
Italy (1992)	69	54	1.28
Ireland (1992)	69	55	1.26
Great Britain (1992)	68	56	1.21
France (1992)	68	56	1.21
Belgium (1992)	64	54	1.19
Denmark (1992)	72	61	1.18
The Netherlands (1992)	69	59	1.17
Germany (1992)	70	60	1.17
Spain (1992)	71	62	1.15
Portugal (1992)	71	67	1.06
Greece (1992)	75	74	1.01
Japan (1991)	55	56	0.98

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); unpublished tabulations; and J. D. Miller, R. Pardo, and F. Niwa, *Public Attitudes Toward Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Madrid: BBV Foundation, 1997).

Appendix table 7-17. Public assessments of funding of scientific research by the Federal Government, by selected characteristics: 1985-97 (Percentages)

Characteristic	1985	1988	1990	1992	1995	1997
All adults						
Strongly agree	9	16	17	14	19	22
Agree	70	65	62	63	61	57
Don't know	5	4	4	3	3	3
Disagree	16	14	15	18	17	15
Strongly disagree	0	1	2	2	2	3
Male						
Strongly agree	11	20	23	17	19	24
Agree	71	63	60	62	60	54
Don't know	2	2	2	2	2	3
Disagree	_ 15	13	13	_ 17	_ 18	16
Strongly disagree	1	2	2	2	1	3
Female		2	2	2	'	0
Strongly agree	8	11	13	11	15	20
	68	68	65	64	62	59
Agree Don't know	8	6	5	4	5	59 4
				•		· ·
Disagree	16	14	16	19	16	15
Strongly disagree	0	1	1	2	2	2
Less than high school graduate	_		40	40	•	
Strongly agree	5	6	10	10	8	20
Agree	65	66	59	61	59	50
Don't know	9	7	8	5	7	5
Disagree	21	18	20	21	24	22
Strongly disagree	0	3	3	3	2	3
High school graduate						
Strongly agree	8	17	18	12	16	19
Agree	72	66	65	64	63	60
Don't know	4	3	2	3	3	3
Disagree	15	13	14	19	17	15
Strongly disagree	1	1	1	2	1	3
Baccalaureate degree						
Strongly agree	19	26	27	22	24	31
Agree	68	62	60	64	62	56
Don't know	2	3	2	2	2	2
Disagree	10	8	10	12	11	10
Strongly disagree	1	1	1	0	1	1
Graduate/professional degree						
Strongly agree	20	29	31	26	43	40
Agree	70	61	58	53	46	51
Don't know	2	2	4	5	2	2
Disagree	8	7	6	14	8	5
Strongly disagree	0	1	1	2	1	2
Attentive public for science and technology	J	ı	ı	۷	1	۷
	17	27	35	28	35	46
Strongly agree	76			∠o 61		
Agree		62	50	- -	48	42
Don't know	0	2	4	1	1	1
Disagree	6	8	10	9	14	7
Strongly disagree	1	1	1	1	2	4

NOTE: Responses are to the question: "Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the Federal Government. Do you strongly agree, agree, disagree, or strongly disagree?"

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

Appendix table 7-18. **Public attitudes toward federal support of basic scientific research, by general attitudes on science and technology and selected characteristics: 1997**(Percentages)

Characteristic	Disagree	Unsure	Agree	Sample size	Gammaª
INDEX OF SCIENTIFIC PROMISE ^b					
All adults	18	3	79	2,000	_
Low score on Index of Scientific Promise	37	9	54	241	
Moderate score on Index of Scientific Promise	25	4	71	626	0.54
High score on Index of Scientific Promise	10	1	89	1,133	
Less than high school graduate	25	5	70	421	_
Low score	35	18	47	57	
Moderate score	39	4	57	147	0.51
High score	14	1	85	217	
High school graduate	18	4	78	1,188	_
Low score	41	7	52	152	
Moderate score	23	5	72	379	0.54
High score	10	2	88	657	
Baccalaureate degree	10	2	88	393	_
Low score	21	6	73	33	
Moderate score	14	2	84	100	0.42
High score	7	1	92	260	
INDEX OF SCIENTIFIC RESERVATIONS°					
All adults	18	3	79	2,000	-
Low score on Index of Scientific Reservations	9	1	90	831	
Moderate score on Index of Scientific Reservations	23	4	73	806	-0.43
High score on Index of Scientific Reservations	27	6	67	363	
Less than high school graduate	25	4	71	421	_
Low score	8	0	92	79	
Moderate score	37	5	58	218	-0.07
High score	16	6	78	122	
High school graduate	18	3	79	1,188	_
Low score	9	2	89	493	
Moderate score	20	4	76	478	-0.47
High score	33	7	60	217	
Baccalaureate degree	10	1	89	393	_
Low score	8	1	91	254	
Moderate score	10	3	87	109	-0.27
High score	21	4	75	24	

^aThe ordinal correlation coefficient gamma is a measure of the bivariate relationship between two ordinal variables. It is equivalent to R² for two interval variables. See L.A. Goodman and W.H. Kruskal "Measures of Association for Cross-Classifications," *Journal of the American Statistical Association* Vol. 49 (1954): 732-64; and H.L. Costner, "Criteria for Measures of Association," *American Sociological Review* Vol. 30, No. 3 (1965): 341-53.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-11.

^bThe Index of Scientific Promise scores are classified as follows: low = 0-49; moderate = 50-74; and high = 75-100.

[°]The Index of Scientific Reservations scores are classified as follows: low = 0-29; moderate = 30-54; and high = 55+.

Appendix table 7-19.

Public confidence in the people running various institutions: 1973-96 (Percentages)

Institution	1973	1973 1974 1975	1975	1976	1977	1978	1980	1982	1983	1984	1986	1987	1988	1989	1990	1991	1993	1994	1996
Average ^a	30	33	26	29	31	24	26	26	24	27	25	28	26	25	25	29	22	22	23
Medicine	54	90	20	24	51	46	52	45	51	20	46	25	51	46	46	48	39	4	45
Scientific community	37	45	39	43	41	36	41	38	4	44	39	45	39	40	37	4	37	38	39
U.S. Supreme Court	31	33	31	35	35	28	25	30	27	33	30	36	35	34	35	37	31	30	28
Military	35	40	35	33	36	59	58	31	59	36	31	34	34	32	33	90	42	37	37
Education	37	49	31	37	4	28	30	33	59	28	28	35	59	30	27	30	22	22	23
Major companies	59	31	19	22	27	22	27	23	24	30	24	30	25	24	25	20	21	25	23
Organized religion	35	4	24	30	40	31	35	32	28	31	25	59	20	22	23	25	23	24	25
Exec. branch of Fed. Govt	59	4	13	13	28	12	12	19	13	18	21	18	16	20	23	56	12	Ξ	10
Banks & financial																			
institutions	I	ı	32	33	45	33	35	27	24	31	21	27	27	19	18	12	15	18	25
Congress	23	17	13	4	19	13	6	13	10	12	16	16	15	17	15	18	7	∞	œ
Press	23	56	24	58	22	20	22	18	13	17	18	18	18	17	15	16	Ξ	∞	Ξ
	18	23	18	19	17	4	16	4	12	13	15	12	4	4	4	4	12	ဝ	10
Organized labor	15	18	10	12	15	Ξ	15	12	∞	∞	ω	10	10	6	Ξ	7	∞	10	1
Sample size1,504 1,484 1,490 1,4	1,504	1,484	1,490	1,499	1,530 1	1,532	1,468	1,506	1,599	686	1,470 1	1,466	997 1	1,035	899	1,017	1,057	2,011	,925
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1																			

^{- =} not asked

NOTES: Percentages represent those respondents expressing a "great deal of confidence" when asked the following: "I am going to name some institutions in this country. As far as the people running these institutions are concerned, would you say that you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?" Survey was not conducted in 1979 and 1981, and the question was not asked in 1985.

^aAverage does not include banks and financial institutions.

SOURCE: J.A. Davis and T.W. Smith, General Social Surveys, Cumulative Codebook (Chicago: University of Chicago, National Opinion Research Center, annual series).

See figure 7-12.

Appendix table 7-20. Public assessments of scientific research, by selected characteristics: 1979-97

Characteristic	1979	1981	1985	1988	1990	1992	1995	1997
		Perce	ntages					
All adults								
Benefits strongly outweigh harmful results	46	42	44	57	47	42	43	47
Benefits slightly outweigh harmful results	24	28	24	25	25	31	29	28
Benefits equal harmful results	19	13	13	5	15	11	16	13
Harmful results slightly outweigh benefits	7	12	13	9	10	12	10	8
Harmful results strongly outweigh benefits	4	5	6	4	3	4	3	4
Male								
Benefits strongly outweigh harmful results	51	48	48	59	54	45	47	52
Benefits slightly outweigh harmful results	23	27	23	25	24	30	28	27
Benefits equal harmful results	16	11	10	5	9	9	13	10
Harmful results slightly outweigh benefits	7	10	13	7	9	11	9	7
Harmful results strongly outweigh benefits	3	5	6	4	4	5	4	
Female								
Benefits strongly outweigh harmful results	42	37	40	55	40	40	39	42
Benefits slightly outweigh harmful results	25	28	26	25	26	31	30	29
Benefits equal harmful results	23	16	14	6	20	13	19	15
Harmful results slightly outweigh benefits	6	14	14	10	11	12	10	10
Harmful results strongly outweigh benefits	4	5	6	4	3	4	3	4
Less than high school graduate								
Benefits strongly outweigh harmful results	26	26	20	37	24	24	18	30
Benefits slightly outweigh harmful results	25	23	21	30	25	33	30	28
Benefits equal harmful results	32	25	26	9	30	17	34	21
Harmful results slightly outweigh benefits	12	18	20	17	17	20	14	18
Harmful results strongly outweigh benefits	5	9	13	7	4	7	3	3
High school graduate	_	_		-		-		_
Benefits strongly outweigh harmful results	50	43	47	59	49	41	44	46
Benefits slightly outweigh harmful results	26	31	26	25	27	32	30	30
Benefits equal harmful results	16	10	10	5	11	10	13	13
Harmful results slightly outweigh benefits	5	12	13	7	10	12	10	6
Harmful results strongly outweigh benefits	3	4	4	4	3	5	3	5
Baccalaureate or higher degree	· ·	•	·	•	J	· ·	· ·	· ·
Benefits strongly outweigh harmful results	69	64	67	80	72	66	67	67
Benefits slightly outweigh harmful results	18	22	23	16	18	22	23	23
Benefits equal harmful results	8	7	2	1	6	8	6	6
Harmful results slightly outweigh benefits	2	4	6	2	2	3	3	3
Harmful results strongly outweigh benefits	3	2	2	1	2	2	1	1
Attentive public for science and technology	Ü	_	-	•	_	-		
Benefits strongly outweigh harmful results	67	63	59	62	61	48	64	64
Benefits slightly outweigh harmful results	16	20	17	23	19	27	21	19
Benefits equal harmful results	8	5	7	6	10	12	8	6
Harmful results slightly outweigh benefits	4	8	13	6	6	9	3	8
Harmful results strongly outweigh benefits	5	4	4	3	4	4	4	3
Training results strongly outweigh benefits			le size					- 3
All adults	1,635	1,536	2,005	975	2,033	997	2,006	2,000
Male	773	724	950	475	964	464	953	930
Female	862	812	1,054	500	1,070	533	1,053	1,070
Less than high school graduate	465	385	507	259	495	215	418	420
High school graduate	932	886	1,147	546	1,202	579	1,196	1,188
Baccalaureate or higher degree	238	264	349	170	336	203	392	392
0 0								288
Attentive public for science and technology ^a	154	381	235	116	229	94	195	

NOTES: Responses are for the following statements: "People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of harmful results or only slightly?" Percentages may not total 100 because of rounding.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

Appendix table 7-21. Public assessments of nuclear power, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Percentages				
All adults						
Benefits strongly outweigh harmful results	28	18	24	17	21	22
Benefits slightly outweigh harmful results	22	24	23	30	22	23
Benefits equal harmful results	6	11	12	11	14	18
Harmful results slightly outweigh benefits	13	17	13	15	21	17
Harmful results strongly outweigh benefits	31	30	28	27	21	20
Male						
Benefits strongly outweigh harmful results	38	23	31	21	29	28
Benefits slightly outweigh harmful results	22	27	24	34	23	26
Benefits equal harmful results	4	7	8	7	8	13
Harmful results slightly outweigh benefits	9	15	11	10	21	13
Harmful results strongly outweigh benefits	27	28	26	28	19	20
Female						
Benefits strongly outweigh harmful results	19	14	17	14	14	17
Benefits slightly outweigh harmful results	22	21	21	27	21	20
Benefits equal harmful results	8	14	16	14	20	22
Harmful results slightly outweigh benefits	16	19	16	18	23	20
Harmful results strongly outweigh benefits	35	32	30	27	22	21
Less than high school graduate						
Benefits strongly outweigh harmful results	28	15	21	10	15	20
Benefits slightly outweigh harmful results	24	25	21	37	16	17
Benefits equal harmful results	8	17	23	11	25	25
Harmful results slightly outweigh benefits	14	19	13	13	28	21
Harmful results strongly outweigh benefits	26	24	22	29	16	17
High school graduate						
Benefits strongly outweigh harmful results	27	18	23	19	21	22
Benefits slightly outweigh harmful results	21	23	23	26	23	23
Benefits equal harmful results	6	9	9	11	13	16
Harmful results slightly outweigh benefits	13	17	14	16	21	16
Harmful results strongly outweigh benefits	33	33	31	28	23	23
Baccalaureate or higher degree			٠.			
Benefits strongly outweigh harmful results	29	22	32	19	28	25
Benefits slightly outweigh harmful results	21	25	23	34	26	26
Benefits equal harmful results	3	7	7	10	8	14
Harmful results slightly outweigh benefits	13	14	13	14	18	17
Harmful results strongly outweigh benefits	3	32	25	23	19	18
Attentive public for science and technology	J	<u> </u>		20		.0
Benefits strongly outweigh harmful results	35	26	30	24	28	25
Benefits slightly outweigh harmful results	20	24	27	30	24	25
Benefits equal harmful results	1	9	6	10	10	11
Harmful results slightly outweigh benefits	12	16	9	9	22	17
Harmful results strongly outweigh benefits	32	25	28	27	18	22

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Appendix table 7-21. Public assessments of nuclear power, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Sample size				
All adults	2,005	2,041	2,033	997	2,006	2,000
Male	950	958	964	464	953	930
Female	1,054	1,084	1,070	533	1,053	1,070
Less than high school graduate	507	530	495	215	418	420
High school graduate	1,143	1,158	1,202	579	1,196	1,188
Baccalaureate or higher degree	349	353	336	203	392	392
Attentive public for science and technology	235	233	229	94	195	288

NOTES: In 1985, 1988, 1990, 1995 and 1997, the question was worded, "In the current debate over the use of nuclear reactors to generate electricity, there is a broad agreement that there are some risks and some benefits associated with nuclear power. In your opinion, have the benefits associated with nuclear power outweighed the harmful results, or have the harmful results associated with nuclear power been greater than its benefits? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of beneficial results or only slightly? "In 1992, the question was worded, "In the current debate over the use of nuclear reactors to generate electricity, there is broad agreement that there are some costs and some benefits associated with nuclear power. In your opinion, are the costs associated with nuclear power greater than the benefits, or are the benefits associated with nuclear power greater than the costs? Would you say that the benefits have substantially exceeded the costs or only slightly exceeded the costs? Would you say that the costs substantially exceeded the benefits or only slightly exceeded the benefits?" Percentages may not total 100 because of rounding.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-14.

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Appendix table 7-22. Public assessments of genetic engineering, by selected characteristics: 1985-97

Characteristic	1985	1990	1995	1997
	Percentage	es		
All adults				
Benefits strongly outweigh harmful results	23	20	21	19
Benefits slightly outweigh harmful results	26	27	22	23
Benefits equal harmful results	12	16	22	22
Harmful results slightly outweigh benefits	14	19	23	20
Harmful results strongly outweigh benefits	25	18	12	16
Male 37 3				
Benefits strongly outweigh harmful results	26	21	24	23
Benefits slightly outweigh harmful results	28	31	22	26
Benefits equal harmful results	11	14	21	20
Harmful results slightly outweigh benefits	13	18	22	17
Harmful results strongly outweigh benefits	22	16	10	14
Female				
Benefits strongly outweigh harmful results	19	19	18	16
Benefits slightly outweigh harmful results	25	23	22	21
Benefits equal harmful results	14	17	22	23
Harmful results slightly outweigh benefits	15	21	23	22
Harmful results strongly outweigh benefits	27	20	15	18
_ess than high school graduate		20	10	.0
Benefits strongly outweigh harmful results	19	16	10	15
Benefits slightly outweigh harmful results	29	27	19	18
Benefits equal harmful results	16	25	30	23
Harmful results slightly outweigh benefits	12	17	29	30
Harmful results strongly outweigh benefits	24	15	13	14
High school graduate	24	10	10	17
Benefits strongly outweigh harmful results	21	19	20	18
Benefits slightly outweigh harmful results	24	27	21	24
Benefits equal harmful results	13	12	21	21
Harmful results slightly outweigh benefits	15	21	23	18
	27	21	14	19
Harmful results strongly outweigh benefits	21	21	14	19
Baccalaureate or higher degree	00	20	0.E	07
Benefits strongly outweigh harmful results	33	29	35	27
Benefits slightly outweigh harmful results	29	28	30	28
Benefits equal harmful results	7	15	16	21
Harmful results slightly outweigh benefits	13	15	14	14
Harmful results strongly outweigh benefits	18	13	6	10
Attentive public for science and technology	0.7	20	40	
Benefits strongly outweigh harmful results	37	32	42	36
Benefits slightly outweigh harmful results	28	30	22	24
Benefits equal harmful results	9	9	16	13
Harmful results slightly outweigh benefits	12	12	13	16
Harmful results strongly outweigh benefits	14	17	7	11
Attentive public for medical research				
Benefits strongly outweigh harmful results	29	31	34	27
Benefits slightly outweigh harmful results	24	27	21	25
Benefits equal harmful results	12	12	17	18
Harmful results slightly outweigh benefits	11	17	18	18
Harmful results strongly outweigh benefits	24	13	9	12

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Appendix table 7-22.

Public assessments of genetic engineering, by selected characteristics: 1985-97

Characteristic	1985	1990	1995	1997
	Sample si	ze		
All adults	2,005	2,033	2,006	2,000
Male	950	964	953	930
Female	1,054	1,070	1,053	1,070
Less than high school graduate	507	495	418	420
High school graduate	1,143	1,179	1,196	1,188
Baccalaureate or higher degree	349	359	392	392
Attentive public for science and				
technology	235	229	195	288
Attentive public for medical research	349	337	310	377

NOTES: In 1985, the question was worded, "Some persons have argued that the creation of new life forms through genetic engineering constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, are the risks of genetic engineering greater than the benefits, or are the benefits of genetic engineering research greater than the risks? Would you say that the benefits are substantially greater than the risks, or only slightly greater than the risks? Would you say that the risks are substantially greater than the benefits or only slightly greater than the benefits?" In 1990, the question was worded, "Some persons have argued that the creation of new life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, are the risks of genetic engineering research greater than its benefits, or are the benefits of genetic engineering research greater than its risks? Would you say that the benefits have substantially exceeded the risks or only slightly exceeded the risks? Would you say that the risks have substantially exceeded the benefits or only slightly exceeded the benefits?" In 1995, the question was worded, "Some persons have argued that the creation of new life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, have the benefits of genetic engineering research outweighed the harmful results, or have the harmful results of genetic engineering research been greater than its benefits? Would you say that balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of harmful results or only slightly?" In 1997, half of the respondents were asked the question used in 1995. The other half were asked: "Some persons have argued that the modification of existing life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, have the benefits of engineering research outweighed the harmful results, or have the harmful results of genetic engineering research been greater than its benefits? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of harmful results or only slightly?" Percentages may not total 100 because of rounding.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-15.

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Appendix table 7-23. Public assessments of space exploration, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Percentages				
All adults						
Benefits strongly outweigh costs	27	22	18	17	22	24
Benefits slightly outweigh costs	27	25	25	26	24	24
Benefits equal costs	7	9	9	9	8	10
Costs slightly outweigh benefits	15	18	17	22	17	17
Costs strongly outweigh benefits	24	26	31	26	28	25
Male						
Benefits strongly outweigh costs	33	28	23	33	28	31
Benefits slightly outweigh costs	31	27	26	26	25	25
Benefits equal costs	6	10	8	8	6	8
Costs slightly outweigh benefits	12	13	16	16	16	15
Costs strongly outweigh benefits	18	22	27	27	24	21
Female						
Benefits strongly outweigh costs	21	16	14	11	17	18
Benefits slightly outweigh costs	24	23	24	25	23	23
Benefits equal costs	8	9	10	11	10	12
Costs slightly outweigh benefits	17	23	17	27	18	18
Costs strongly outweigh benefits	30	29	35	26	32	29
ess than high school graduate						
Benefits strongly outweigh costs	22	16	15	14	14	18
Benefits slightly outweigh costs	25	26	20	29	20	21
Benefits equal costs	10	9	17	12	13	16
Costs slightly outweigh benefits	17	21	16	24	21	24
Costs strongly outweigh benefits	26	29	32	21	31	21
High school graduate	20	20	02		01	
Benefits strongly outweigh costs	26	21	17	15	23	23
Benefits slightly outweigh costs	28	25	25	25	24	23
Benefits equal costs	6	9	7	9	6	9
Costs slightly outweigh benefits	14	18	17	23	17	16
Costs strongly outweigh benefits	26	27	34	28	30	29
Baccalaureate or higher degree	20	21	04	20	30	25
Benefits strongly outweigh costs	36	33	27	22	32	31
Benefits slightly outweigh costs	28	26	28	26	27	29
Benefits equal costs	6	10	7	6	8	8
•	13	15	7 16	18	6 14	12
Costs slightly outweigh benefits	17	16	22	28	20	20
Costs strongly outweigh benefits	17	10	22	20	20	20
Attentive public for science and technology	20	20	06	00	20	4.4
Benefits strongly outweigh costs	39	38	26	28	32	44
Benefits slightly outweigh costs	27	28	33	26	25	22
Benefits equal costs	7	6	4	11	7	6
Costs slightly outweigh benefits	13	10	14	20	16	11
Costs strongly outweigh benefits	14	21	23	15	20	17
Attentive public for space exploration	40	40	00	00	50	
Benefits strongly outweigh costs	49	46	36	38	52	57
Benefits slightly outweigh costs	25	30	36	44	23	19
Benefits equal costs	8	4	3	3	4	6
Costs slightly outweigh benefits	11	7	11	6	12	10
Costs strongly outweigh benefits	7	13	14	9	9	8

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Appendix table 7-23. Public assessments of space exploration, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Sample size				
All adults	2,005	2,041	2,033	1,004	2,006	2000
Male	950	958	964	486	953	930
Female	1,054	1,084	1,070	533	1,053	1070
Less than high school graduate	507	530	495	215	418	420
High school graduate	1,147	1,158	1,202	623	1,196	1188
Baccalaureate or higher degree	349	353	336	203	392	392
Attentive public for science and technology	235	233	229	105	195	288
Attentive public for space exploration	184	163	123	51	99	168

NOTES: Responses are to the following questions: "Many current issues in science and technology may be viewed as a judgment of relative benefits. Thinking first about the space program, some persons have argued that the costs of the space program may have exceeded its benefits, while other people have argued that the benefits of space exploration have exceeded its costs. In your opinion, have the costs of space exploration exceeded its benefits, or have the benefits of space exploration exceeded its costs? Would you say that the benefits have substantially exceeded the costs, or only slightly exceeded the costs? Would you say that the costs have substantially exceeded the benefits?" Percentages may not total 100 because of rounding.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-16.

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Appendix table 7-24. Public use of various sources of information, by selected characteristics: 1997 (Percentages)

o de la companya de l	Read news- paper every	Read at least 1 news maga-zine	Watch TV news	Listen to radio news	Public	Public library	Read at least 1 science maga-zine/	Watch 1+ science TV programs/	Visit science museums	Purc boo	Purchase 1+ books/yr	World Wide Web 1+	Sample
Citalacteristic	day	egulariy	ı +ı II/ day	ı+ııı/day	l visiu yi	o visits/yi			14/ year	Ś	Science	WW /6	9716
All adults	46	4	89	28	20	45	15	53	09	61	31	15	2,000
Male	49	15	63	59	89	4	20	26	63	22	32	20	930
Female	43	4	72	27	72	48	Ξ	20	29	99	29	10	1,070
Formal education													
Less than high school	4	9	80	31	52	31	6	45	34	33	o	4	420
High school graduate	44	14	29	27	71	43	4	55	64	62	31	=	1,188
Baccalaureate degree	23	22	29	27	87	89	25	22	78	82	51	35	257
Grad./professional degree	29	27	54	27	84	63	29	52	75	87	26	37	135
Science/mathematics educationa													
Low	43	10	74	26	29	33	တ	48	48	48	18	4	1,112
Middle	47	18	65	34	82	22	14	26	75	20	38	19	209
High	53	22	54	27	82	63	33	62	78	98	28	38	379
Attentiveness to science & tech.													
Attentive public	62	25	20	27	78	09	41	64	89	75	44	30	288
Interested public	38	14	89	28	74	48	13	26	99	92	35	15	918
Residual public	42	Ξ	89	32	62	35	7	44	51	21	20	6	794
Access to cable/satellite TV													
Have cable TV	49	15	89	27	72	45	15	22	62	62	31	17	1,331
Have satellite dish	52	10	64	20	20	29	21	26	22	09	32	17	26
Have neither	32	13	69	33	69	47	41	42	25	28	29	10	572

shows?"; "Now, let me ask you about your use of museums, zoos, and similar institutions. I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during any television shows that focus primarily on science or nature? Which science or nature show do you watch most often? About how many times a month do you watch this show?"; and "On an average day, about the last year, that is, the last 12 months. If you did not visit any given place, just say none. A natural history museum—how many times did you visit it during the last year? A zoo or an aquarium—how many times NOTE: Responses are to the statements: "How often do you read a newspaper: every day, a few times a week, once a week, or less than once a week?"; "Are there any magazines that you read regularly, that is, did you visit it during the last year? A science or technology museum—how many times did you visit it during the last year? A public library—how many times did you visit it during the last year? A science or technology museum—how many times did you visit it during the last year?", "Do you watch most of the time? What magazine would that be?"; "Altogether, on an average day, about how many hours would you say that you watch television? About how many of those hours are news reports or news how many hours would you say that you listen to a radio? About how many of those hours are news reports or news shows?" *Respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as ^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to members of the residual public for science and technology

This category includes 79 respondents who reported that they did not watch any television.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-25. Public use of information on an annual basis, by selected characteristics: 1997

		Hour	Hours/year watching/listening to	ning/listenir	ng to	Cop	Copies read/year	ar	Visits/year	year	Number borrowed/year	rowed/year	
Characteristic	Total TV	TV	Science TV	Total radio	Radio	News- papers	News maga- zines	Science maga- zines	Science	Public library	Books	Video- tapes	Sample size
All adults	1,075	432	72	944	228	196	3.0	1.7	2.2	11.0	12.1	2.0	2,000
Male	992 1,147	387 471	82 62	986	262 198	206 186	2.8	2.5	2.0	9.2	7.7 15.9	1.3	930 1,070
Less than high school	1,495	553	48	904	207	178	1.7	0.4	0.1	7.6	5.5	0.5	420
nigh school graduate Baccalaureate degree	1,040 743	314 314	72	798	234 234	192 219	6.9 0.4	3.0	3.4 3.4	16.8	20.0	3.0	1,100
Grad./professional degree Science/math education ^a	718	335	59	584	232	238	6.2	4.0	3.3	15.9	21.1	2.2	135
Low	1,235	489 394	63	887	208	185	2.0	0. t	2.0	7.7	8.8	- - 0	1,112
High Attentiveness to science and	744	317	62	850	243	220	9.4	. 4 5 L.	8. 8.	15.3	19.9	3.0	379
technology~ Attentive public	1,093	200	102	957	254	298	6.5	5.2	3.1	16.7	18.0	2.3	288
Interested public	1,044	443	84	931	238	171	2.5	4.1	2.5	11.1	13.0	1.5	918
Residual publicAccess to cable/satellite TV	1,105	395	46	954	205	186	1.8	6:0	1.7	8.0	8.8	1.0	794
Have cable TV	1,149	459	84	922	217	209	3.0	1.7	2.0	10.6	11.5	1.0	1,331
Have satellite dish	1,154	373	109	1,050	177	218	4.	3.2	2.0	7.5	9.6	4.1	26
Have neither	889	379	35	888	261	160	2.3	1.7	2.2	11.0	13.9	2.3	572

NOTE: Responses are to the statements: "Altogether, on an average day, about how many hours would you say that you watch television? About how many of those hours are news reports or news shows?" "Now, you borrow any books from the public library? (if yes):About how many books did you borrow during the last year?" "During the last 12 months, did you borrow any videotapes from the public library? (if yes):About during the last year? A science or technology museum—how many times did you visit it during the last year? A public library—how many times did you visit it during the last year?"; "During the last 12 months, did let me ask you about your use of museums, zoos, and similar institutions. I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during the last year, that is, the last 12 months. If you did not visit any given place, just say none. A natural history museum—how many times did you visit it during the last year? A zoo or an aquarium—how many times did you visit it how many videotapes did you borrow during the last year?" "Do you watch any television shows that focus primarily on science or nature? Which science or nature show do you watch most often? About how many times a month do you watch this show?"; and "On an average day, about how many hours would you say that you listen to a radio? About how many of those hours are news reports or news shows?" *Respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology

^cThis category includes 79 respondents who reported that they did not watch any television.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Science Resources Studies Division.

See figures 7-18 and 7-19.

Appendix table 7-26. Public's access to computers from work and home, by selected characteristics: 1983-97

Characteristic	1983	1985	1988	1990	1995	1997
		Percentages				
All adults						
No access	70	66	62	58	46	43
Access from work or home	27	28	29	30	33	34
Access from work and home	3	6	9	12	21	23
Male						
No access	68	62	59	55	41	42
Access from work or home	28	30	30	30	34	32
Access from work and home	4	8	11	15	25	26
Female						
No access	72	69	66	61	50	44
Access from work or home	26	26	28	31	33	36
Access from work and home	2	5	6	8	17	20
Less than high school graduate						
No access	94	87	92	85	80	79
Access from work or home	6	13	8	14	18	18
Access from work and home	0	0	0	1	2	3
High school graduate						
No access	66	65	58	55	42	40
Access from work or home	31	30	35	34	38	39
Access from work and home	3	5	7	11	20	21
Baccalaureate or higher degree						
No access	47	40	33	29	18	12
Access from work or home	45	43	41	41	36	38
Access from work and home	8	17	26	30	46	50
Attentive public for science and technology ^a						
No access	61	56	50	44	31	34
Access from work or home	29	33	35	31	31	36
Access from work and home	10	11	15	25	38	30
		Sample size				
All adults	631	2,005	2,041	2,033	2,006	2,000
Male	775	950	958	964	953	930
Female	856	1,054	1,084	1,070	1,053	1,070
Less than high school graduate	404	507	530	495	418	420
High school graduate	941	1,147	1,158	1,202	1,196	1188
Baccalaureate or higher degree	282	349	353	336	392	392
Attentive public for science and technology	208	235	233	229	195	288

NOTE: In 1985, 1988, 1990, 1995 and 1997, the question was worded, "Do you use a computer in your work? About how many hours do you personally use your work computer in a typical week? Do you presently have a home computer in your household? About how many hours do you personally use your home computer in a typical week?" In 1983, the question was worded, "Do you use computers or word processing equipment in your work?..."

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figures 7-20 and 8-24.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

Public's access to and use of computers at home and work, by selected characteristics: 1997 Appendix table 7-27 (Percentages)

	Use	Have	Com-	Com-			Hon	Home computer	iter		Work computer	mputer	- Nse	Use (hours/year)	ar)
Characteristic	com- puter in work	com- puter at home	puter at home & work	puter at home or work	No com- puter	Modem	On-line service	CD- ROM	E-mail address	Access	E-mail address	Access	Work	Home	On-line hrs/year
All adults	38	43	23	57	43	33	18	29	18	16	16	14	369	130	29
Nale	41	44	56	28	42	35	21	31	20	20	8 :	18	371	161	37
Female	35	4	20	26	4 4	33	15	56	15	5	4	÷	368	102	23
Less than high school	9	19	က	21	6/	13	-	∞	9	2	-	7	31	51	4
High school graduate	36	42	21	09	40	31	17	59	17	14	12	Ξ	390	119	56
Baccalaureate degree	29	29	47	87	13	24	32	49	31	32	40	36	695	237	09
Grad./professional degree	89	92	24	88	12	62	14	22	37	38	43	45	612	263	69
	00	96	0	5	09	C	đ	17	α	7	Ľ	Ľ	221	7.	10
Middle	51	53	32	75	28	42	23	38	25	22	22	. 6	439	162	3 - 5
High	64	89	44	88	12	26	37	51	36	36	38	35	200	257	74
Attentiveness to science and technology ^b															
Attentive public	42	54	30	99	34	47	26	40	30	30	23	23	465	225	22
Interested public	42	46	56	63	37	34	20	31	18	17	17	16	398	152	32
Residual public	31	34	18	48	52	26	13	22	13	10	12	о	301	69	16
Access to cable/satellite IV	;		į		6	(((ļ	ļ			ć
Have cable TV	41	46	22	61	ဓ္ဌ	36	20	35	20	0	17	15	401	143	32
Have satellite dish	39	45	21	63	37	33	17	31	18	19	12	우	308	134	ලි
Have neither°	30	35	17	47	23	24	12	21	12	Ξ	12	13	306	26	20

WWW = World Wide Web

work? Do you have access to the World Wide Web through your work computer? Do you presently have a home computer in your household? About how many hours do you personally use your home computer in Online, or any other dial-in-service? About how many hours a month do you use your dial-in or network service? Do you have an e-mail address that you use with your home computer? Do you ever access the a typical week? Do you have a CD-ROM reader in your home computer? Do you have a modem in your home computer? Do you presently subscribe to any network service like CompuServe, Prodigy, America NOTE: Responses are to the statements: "Do you use a computer in your work? About how many hours do you personally use your work computer in a typical week? Do you have an e-mail address for use at World Wide Web through your home computer?" *Respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technology. All other individuals are classified as a member of the interested public for at least one of those issues is classified as a member of the interested public for at least one of those issues is classified as members of the residual public for science and technology

This category includes 79 respondents who reported that they did not watch any television.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 8-1. Uses of computers in the workplace: 1993

	Workers who us	se this application
	Number	
Application	(thousands)	Percentage
Analysis	13,018	25
Bookkeeping	13,236	26
Bulletin boards	4,315	8
Calendar scheduling	11,846	23
Communications	16,058	31
Computer-assisted design	3,856	8
Databases	17,556	34
Desktop publishing	5,933	12
Educational programs	4,689	9
E-mail	10,872	21
Games	2,930	6
Graphics	8,671	17
Inventory control	12,823	25
Invoicing	10,057	20
Learn to use	4,820	9
Programming	6,671	13
Sales	7,629	15
Spreadsheets	12,045	24
Telemarketing	1,656	3
Word processing	22,624	44
Other	9,841	19
Don't know	2,895	6
Total workers who use a computer	51,106	

 $SOURCE: U.S.\ Bureau\ of\ the\ Census,\ Current\ Population\ Survey,\ October\ 1993.\ Available\ from\ << http://www.census.gov/population/socdemo/computer/compusea/text>>.$

Appendix table 8-2. Index of real net information technologies capital stock in the private sector: 1960-95

	Office, computing, and accounting machinery	Communications equipment	All nonresidential durable equipment
1960	0.23	8.15	25.62
1961	0.24	9.27	26.18
1962	0.25	10.56	27.06
1963	0.29	11.56	28.12
1964	0.34	12.50	29.56
1965	0.40	13.69	31.67
1966	0.53	15.09	34.26
1967	0.65	16.46	36.44
1968	0.76	17.84	38.76
1969	0.93	19.64	41.32
1970	1.09	21.64	43.32
1971	1.28	23.25	45.08
1972	1.57	24.52	47.46
1973	1.90	26.43	50.92
1974	2.34	28.26	54.11
1975	2.64	29.63	55.89
1976	3.12	31.22	57.88
1977	3.78	34.23	60.81
1978	5.33	38.13	64.75
1979	7.57	43.01	68.95
1980	10.48	48.46	71.95
1981	14.25	53.71	74.76
1982	17.19	58.50	76.22
1983	22.87	62.70	77.86
1984	32.03	67.54	81.11
1985	41.88	72.67	84.45
1986	51.55	77.58	87.32
1987	59.61	81.59	89.63
1988	66.84	86.52	92.30
1989	75.82	90.75	95.03
1990	81.69	94.58	97.22
1991	87.31	97.21	98.39
1992	100.00	100.00	100.00
1993	119.03	102.20	102.72
1994	143.14	106.43	106.90
1995	178.09	112.78	111.89

NOTE: Index is chain-link index; values are expressed relative to 1992 dollars.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business (May 1997), table 4, pp. 82-84.

See figure 8-2.

Appendix table 8-3. Gross product by industry as a share of gross domestic product: 1959-94, selected years (Percentages)

Industry	1959	1967	1977	1982	1987	1988	1989	1990	1991	1992	1993	1994
Goods, total	38.9	36.0	32.8	31.0	27.3	27.6	26.8	26.2	24.7	24.0	23.7	24.2
Agriculture, forestry, and fishing	4.0	3.0	2.7	2.4	1.9	1.8	1.9	1.9	1.7	1.8	1.6	1.7
Mining	2.5	1.8	2.7	4.6	1.9	2.0	1.8	2.0	1.7	1.5	4.1	1.3
Construction	4.7	4.7	4.6	4.0	4.6	4.6	4.5	4.3	3.9	3.7	3.7	3.9
Manufacturing	27.7	26.5	22.8	20.0	18.9	19.2	18.6	18.0	17.4	17.0	17.0	17.3
Services, total	48.8	49.8	51.9	53.9	59.1	59.7	59.6	59.8	61.0	61.3	61.6	62.0
Transportation and public utilities ^a	8.9	8.5	8.9	9.0	0.6	8.8	8.5	8.4	8.7	8.5	8.6	8.7
Wholesale trade	7.1	6.9	7.0	6.8	6.4	6.7	9.9	6.4	9.9	6.5	6.5	6.7
Retail trade	9.7	9.4	9.4	8.9	9.3	9.1	0.6	8.8	8.7	8.7	8.7	8.8
Finance, insurance, and real estate	13.6	14.1	14.0	15.6	17.7	17.7	17.7	17.8	18.3	18.4	18.5	18.4
Professional ^b	5.2	6.5	8.6	10.6	12.5	10.8	11.0	11.5	11.7	12.1	12.2	12.3
Personal ^c	3.4	3.5	3.1	3.1	3.4	3.5	3.4	3.6	3.5	3.6	3.5	3.6
Other ^d	6.0	6.0	0.8	0.8	6.0	3.2	3.7	3.6	3.4	3.5	3.5	3.6
Government	12.8	14.1	14.5	14.2	13.9	13.8	13.6	13.8	14.2	14.0	13.7	13.4

NOTE: Shares are based on current dollars.

^aThis includes communications.

Professional services include business, health, legal, educational, social, and (through 1987) miscellaneous professional services.

Personal services include hotels and lodging, personal, auto repair and services, miscellaneous repair, amusement and recreation, and private household services.

^dOther services include motion pictures, membership organizations, and (after 1987) other.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business (August 1996), table 11.

See figures 8-6 and 8-7.

Appendix table 8-4. **U.S. employment by industrial sector: 1950-90, selected years** (Percentages)

Industry	1950	1960	1970	1980	1990
Total	100.0	100.0	100.0	100.0	100.0
Extractive	14.4	8.1	4.6	4.5	3.5
Agriculture	12.7	7.0	3.7	3.6	2.8
Mining	1.7	1.1	0.8	1.0	0.6
Transformative	33.9	35.9	33.0	29.6	25.6
Constructive	6.2	6.2	6.0	6.2	6.5
Utilities	1.4	1.4	1.1	1.2	1.1
Manufacturing	26.2	28.3	25.9	22.2	18.0
Food	2.7	3.1	1.9	1.9	1.6
Textiles	2.2	3.3	1.3	0.8	0.6
Metal	3.6	3.9	3.1	2.7	1.8
Machinery	3.7	7.5	5.1	5.2	3.8
Chemical	1.7	1.8	1.5	1.6	1.3
Miscellaneous manufacturing	12.3	8.7	12.9	10.0	8.9
Distributive services	22.4	21.9	22.4	21.0	20.6
Transportation	5.3	4.4	3.9	3.7	3.5
Communication	1.2	1.3	1.5	1.5	1.3
Wholesale	3.5	3.6	4.0	3.9	3.9
Retail	12.3	12.5	12.9	11.9	11.8
Producer services	4.8	6.6	8.2	10.5	14.0
Banking	1.1	1.6	2.2	2.6	2.9
Insurance	1.1	1.7	1.8	2.6 1.9	2.9
	1.0	1.0	1.0	1.6	1.8
Real estate	0.2		0.4		0.7
Engineering	0.2	0.3	0.4	0.6	
Accounting		0.3		0.5	0.5
Miscellaneous business services	0.6	1.2	1.8	2.6	4.9
Legal services	0.4	0.5	0.5	0.8	1.0
Social services	12.4	16.3	22.0	23.7	24.9
Medical, health services	1.1	1.4	2.4	2.3	4.3
Hospital	1.8	2.7	3.7	5.3	4.0
Education	3.8	5.4	8.5	8.3	7.9
Welfare, religious services	0.7	1.0	1.2	1.6	2.6
Nonprofit organization	0.3	0.4	0.4	0.5	0.4
Postal service	0.8	0.9	1.0	0.7	0.7
Government	3.7	4.3	4.5	4.7	4.8
Miscellaneous social services	0.1	0.2	0.3	0.4	0.2
Personal services	12.1	11.3	10.0	10.5	11.5
Domestic services	3.2	3.1	1.7	1.3	0.9
Hotel	1.0	1.0	1.0	1.1	1.5
Eating, drinking places	3.0	2.9	3.2	4.4	4.8
Repair services	1.7	1.4	1.4	1.3	1.4
Laundry	1.2	1.0	0.8	0.4	0.5
Barber, beauty shops	_	0.8	0.9	0.7	0.7
Entertainment	1.0	0.8	0.8	1.0	1.3
Miscellaneous personal services	1.2	0.4	0.3	0.3	0.4

NOTE: Details may not add to totals because of rounding.

SOURCE: M. Castells, The Rise of the Network Society (Cambridge, MA: Basil Blackwell, 1996).

See figure 8-8.

Appendix table 8-5. Workers who use a computer at work, by sector: 1993

	Total employed in		in sector computer
Sector	sector (thousands)	Number (thousands)	Percentage
Government	5,927	4,137	70
All industries	118,400	51,106	43
Agriculture	3,140	435	14
Mining	689	307	45
Construction	7,567	1,182	16
Manufacturing, total	19,605	8,178	42
Food	1,776	532	30
Tobacco	52	25	48
Apparel	970	143	15
Textiles	664	177	27
Leather and leather products	107	24	22
Lumber and wood	841	114	14
Furniture	665	161	24
Paper and allied products	740	339	46
Printing and publishing	1,705	857	50
Chemicals	1,220	729	60
Petroleum and coal	145	88	61
Rubber and plastics	791	293	37
Stone, clay, and glass	568	165	29
Primary metals	653	217	33
Fabricated metals	1,290	442	34
Non-electric machinery	2,238	1,233	55
Electric machinery	1,689	950	56
Motor vehicles	1,120	428	38
Aircraft	502	335	67
Other transportation	624	376	60
Photo equipment	680	406	60
Toys and sporting goods	128	44	34
Miscellaneous manufactures	437	100	23
Services, total	81,473	36,867	45
Transportation	5,410	1,866	34
Communications	1,637	1,283	78
Utilities	1,501	807	54
Wholesale trade	4,531	2,226	49
Retail trade	18,706	5,837	31
Banking and finance	3,417	2,888	85
Insurance and real estate	4,561	3,094	68
Professional services	31,020	16,515	53
Personal services	10,690	2,351	22
Business services	5,038	2,646	53

SOURCE: U.S. Bureau of the Census, Current Population Survey, October 1993. Available from <">http://www.census.gov/population/socdemo/computer/compusea/text>>>.

See figure 8-9.

Appendix table 8-6. Index of information technologies investments, by industry: 1991-92

Industry	Industry's share of GDP, 1992 (%)	Industry's IT investments 1991 (\$ billion)	Industry's share of IT investments (%)	Investment Index
Manufacturing	17.0	25.30	16.6	0.98
Transportation	3.1	3.80	2.5	0.81
Communications	2.6	21.10	13.9	5.35
Utilities	2.8	8.00	5.3	1.89
Wholesale trade	6.5	17.00	11.2	1.72
Retail trade	8.7	17.90	11.8	1.36
Finance, insurance, and real estate	18.4	38.70	25.4	1.38
Professional and personal services	19.2	20.30	13.3	0.69

IT = information technologies

NOTE: Investment Index equals industry's share of IT investments divided by industry's share of GDP. An index of 1.00 reflects no over- or under-investing in IT relative to the size of the industry.

SOURCES: Industry investments from National Research Council, *Information Technology in the Service Society* (Washington, DC: National Academy Press, 1994), p. 2; share of GDP from U.S. Bureau of Economic Analysis, *Survey of Current Business* (August 1996), p. 137.

See figure 8-10.

Appendix table 8-7. **Technology in public schools: 1992-95**

Technology	Number				Percentage of total	
	1992	1993	1994	1995	1992	1995
Schools with interactive videodisk players ^a	6,502	11,729	19,189	23,112	8	27
Elementary	2,921	5,986	10,043	12,326	6	24
Junior high	1,258	2,386	3,844	4,672	10	34
Senior high	2,106	3,129	5,026	5,805	14	34
Students represented (1,000)	5,781	9,064	13,434	16,060	14	36
Schools with modems ^a	13,597	18,471	24,277	28,275	16	34
Elementary	5,831	8,492	11,679	14,782	11	29
Junior high	2,608	3,431	4,531	5,393	20	39
Senior high	5,001	6,371	7,853	8,620	30	51
Students represented (1,000)	10,717	13,382	16,476	19,326	25	43
Schools with networks ^a	4,184	11,657	19,272	23,402	5	28
Elementary	1,583	4,683	8,477	11,155	3	22
Junior high	776	2,030	3,611	4,425	6	32
Senior high	1,736	4,895	7,104	8,042	10	48
Students represented (1,000)	3,754	8,043	12,713	15,160	9	34
Schools with CD-ROMs ^a	5,706	11,021	24,526	31,501	7	37
Elementary	1,897	4,457	11,794	16,816	4	33
Junior high	1,231	2,326	4,874	6,170	9	45
Senior high	2,543	4,168	7,724	9,063	15	64
Students represented (1,000)	5,298	8,534	15,576	19,501	12	44
Schools with satellite dishesa	1,129	8,812	12,580	14,290	1	17
Elementary	351	2,988	4,269	5,154	1	10
Junior high	166	1,503	2,497	3,004	1	22
Senior high	606	4,292	5,770	6,263	4	37
Students represented (1,000)	1,906	4,668	6,740	7,946	4	18
Schools with cablea	NA	47,745	58,652	62,593	NA	74
Elementary	NA	27,923	35,325	37,730	NA	73
Junior high	NA	9,266	10,696	11,416	NA	83
Senior high	NA	10,296	12,198	13,089	NA	78
Students represented (1,000)	NA	27,324	33,510	35,770	NA	80

NA = not available

NOTE: Elementary includes K-12; preschool, preschool through 8, K-6, and K-8. Junior high includes schools with grade spans of 4-6, 7-8, and 7-9. Senior high includes 7-12, 9-12, 10-12, vocational, technical, and alternative high schools.

SOURCE: U.S. Bureau of the Census, Statistical Abstract of the United States 1996, table 264 (Washington, DC: U.S. Government Printing Office, 1996); data based on surveys conducted by Quality Education Data, Inc.

^aIncludes schools for special education and adult education not shown separately.

Appendix table 8-8. Student use of computers at home and at school, by sex, race/ethnicity, and household income: 1984 and 1993 (Percentages)

					1993		
Characteristic	1984 total	Total	Pre-K and K	Grades 1-8	Grades 9-12	1st to 4th year of college	5th or later year college
Onlaracionatio	Total				J 12	College	College
	07.0	•	se at school	00.0	50.0		50.4
Total	27.3	59.0	26.2	68.9	58.2	55.2	52.1
Sex							
Male	29.0	59.4	25.9	69.5	56.5	57.5	56.7
Female	25.5	58.7	26.5	68.4	60.0	53.3	47.8
Race/ethnicity	00.0	01.0	00.4	70.7	50.0	540	50.0
White	30.0	61.6	29.4	73.7	59.9	54.9	59.8
Black	16.8	51.5	16.5	56.5	54.5	56.9	57.9
Hispanic	18.6	52.3	19.2	58.4	54.1	51.9	53.7
Other	28.6	59.0	23.5	65.7	57.3	60.9	69.4
Household income	10.7	54.0	10.0	55.0	50.0	C1 7	00.7
Less than \$5,000	18.7	51.2	19.6	55.0	50.6	61.7	66.7
\$5,000 to \$9,999	21.0	53.3	24.4	60.3	51.9	53.9	56.2
\$10,000 to \$14,999	22.4	56.4	20.1	64.7	56.7	50.7	76.1
\$15,000 to \$19,999	25.9	58.1	23.8	67.5	57.4	51.2	58.5
\$20,000 to \$24,999	26.7	56.4	23.7	64.3	53.0	57.4	52.4
\$25,000 to \$29,999	30.5	60.0	28.0	70.1	60.3	51.5	58.0
\$30,000 to \$34,999	30.5	59.1	23.7	69.6	59.7	51.7	45.3
\$35,000 to \$39,999	32.3	60.7	27.1	72.1	61.7	49.2	47.9
\$40,000 to \$49,999	32.8	59.3	28.5	70.3	57.2	53.9	48.6
\$50,000 to \$74,999	35.5	62.6	28.6	75.6	61.5	57.4	44.2
\$75,000 or more	36.0	64.6	33.5	78.7	62.5	60.9	47.7
Institution type							
Public	27.4	60.2	30.1	68.6	58.1	53.9	54.1
Private	26.5	52.1	18.7	72.5	60.7	60.7	48.0
		Computer	use at home				
Total	11.5	27.0	15.6	24.7	28.7	32.8	52.6
Sex							
Male	14.0	27.4	15.1	24.8	28.2	36.6	56.1
Female	9.0	26.6	16.1	24.6	29.2	29.7	49.5
Race/ethnicity							
White	13.7	32.8	19.4	31.4	35.9	36.0	53.6
Black	4.9	10.9	4.2	9.0	10.4	19.4	48.1
Hispanic	3.6	10.4	5.7	7.5	9.8	22.0	52.2
Other	9.0	28.7	17.0	23.2	37.0	33.0	47.1
Household income							
Less than \$5,000	2.9	9.7	1.1	4.1	6.8	25.6	45.2
\$5,000 to \$9,999	3.2	8.0	0.9	4.5	5.3	21.3	45.6
\$10,000 to \$14,999	5.0	11.4	4.6	6.4	8.7	29.8	50.0
\$15,000 to \$19,999	7.5	15.1	6.9	10.9	14.1	28.9	43.0
\$20,000 to \$24,999	9.9	16.8	7.4	13.1	17.9	27.7	49.6
\$25,000 to \$29,999	12.8	21.1	12.3	19.3	22.0	26.1	47.0
\$30,000 to \$34,999	15.8	24.1	18.7	20.5	29.1	26.4	44.4
\$35,000 to \$39,999	19.4	27.1	13.0	26.3	28.1	32.7	52.7
\$40,000 to \$49,999	20.4	32.2	21.6	32.9	33.9	32.5	45.9
\$50,000 to \$74,999	24.2	43.0	25.5	45.3	46.4	40.1	58.2
\$75,000 or more	22.1	56.1	38.2	62.3	61.0	47.0	64.7
Institution type							
Public	11.2	25.3	12.1	23.0	27.2	31.9	50.0
Private	13.8	37.4	22.4	41.5	47.2	36.9	57.7

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Appendix table 8-8. Student use of computers at home and at school, by sex, race/ethnicity, and household income: 1984 and 1993 (Percentages)

					1993		
Characteristic	1984 total	Total	Pre-K and K	Grades 1-8	Grades 9-12	1st to 4th year of college	5th or later year of college
	Comp	uter use at ho	me for school	ol work			
Total	4.6	14.9	0.6	10.8	20.9	23.1	36.6
Sex							
Male	5.9	14.8	0.9	10.1	20.5	26.3	40.3
Female	3.3	15.0	0.4	11.5	21.4	20.5	33.2
Race/ethnicity							
White	5.4	18.2	0.8	13.8	26.5	25.7	37.8
Black	2.3	5.7	NA	4.0	6.9	11.5	30.1
Hispanic	1.4	5.6	NA	2.9	6.7	15.9	36.8
Other	3.8	16.0	1.1	9.3	27.0	23.7	29.2
Household income							
Less than \$5,000	1.0	6.7	NA	2.5	4.0	18.7	36.0
\$5,000 to \$9,999	1.5	4.8	NA	1.1	3.6	16.1	35.5
\$10,000 to \$14,999	1.9	7.3	NA	2.6	5.6	25.9	34.6
\$15,000 to \$19,999	3.0	8.6	0.4	4.7	10.8	18.7	31.0
\$20,000 to \$24,999	3.1	9.8	0.7	5.1	12.6	22.9	35.0
\$25,000 to \$29,999	5.1	10.4	1.1	6.3	13.4	19.5	34.9
\$30,000 to \$34,999	4.9	13.0	0.8	8.1	21.9	18.0	35.1
\$35,000 to \$39,999	7.1	15.4	0.8	12.4	21.0	22.6	37.2
\$40,000 to \$49,999	9.2	17.1	1.1	14.7	24.2	22.2	32.1
\$50,000 to \$74,999	11.5	23.2	1.0	19.7	35.0	27.0	38.2
\$75,000 or more	9.8	30.4	0.8	29.4	45.2	30.6	41.5
Institution type							
Public	4.5	14.2	0.5	10.1	19.8	22.7	34.7
Private	5.4	18.8	1.0	17.8	35.4	24.8	40.1

Pre-K and K = prekindergarten and kindergarten

SOURCE: U.S. Bureau of the Census, *Statistical Abstract of the United States, 1996,* table 263 (Washington, DC: U.S. Government Printing Office, 1996). See figures 8-19 and 8-21.

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Appendix table 8-9. Adult use of computers at home, school, and work: 1993 (Percentages)

Characteristic	Uses computer anywhere	Has computer at home	Has computer at home and uses computer at home	Enrolled in school and uses computer at school	Has a job and uses computer at work
Age					
Persons over 18	36.0	25.6	65.6	53.8	45.8
18-21 years	45.9	30.4	62.5	62.3	25.8
22-24 years	43.5	25.4	68.9	53.1	42.1
25-34 years	44.4	25.3	73.8	45.2	49.1
35-44 years	46.7	34.2	68.4	43.0	50.8
45-54 years	43.8	34.4	64.0	40.4	49.8
55-64 years	24.2	19.9	55.9	31.9	37.3
65+ years	4.9	8.4	41.2	36.0	20.3
Race	4.5	0.4	41.2	30.0	20.5
White	27 E	26.0	66.7	EO 1	47.1
	37.5	26.9		53.1	
Black	25.0	13.8	56.8	54.8	36.1
Other	35.6	31.3	55.8	60.3	42.3
Hispanic origin	00.0	10.0	04.0	50.0	00.0
Hispanic	22.0	12.9	61.3	50.0	29.3
Not Hispanic	37.2	26.7	65.8	54.1	47.2
Sex	00.0	07.4	70.0	55.0	40.0
Male	36.2	27.1	70.0	55.9	40.3
Female	35.8	24.3	61.1	51.9	52.4
Marital status					
Married	37.5	29.4	65.3	40.5	48.2
Single	42.5	25.3	68.8	58.9	41.2
Divorced/widowed	23.7	14.0	61.3	45.8	43.1
Uses computer					
At work	100.0	43.2	79.4	48.9	100.0
At home	100.0	100.0	NA	55.9	73.0
Household type					
Married couple	38.6	30.4	64.4	54.2	46.8
Female householder	29.2	14.1	65.0	51.4	45.9
Male householder	33.8	20.0	76.5	55.4	41.2
Region					
Northeast	34.3	25.6	62.2	56.4	46.0
Midwest	37.2	25.1	64.9	30.0	45.8
South	33.8	22.1	65.3	51.8	44.3
West	39.6	31.8	69.3	47.3	48.2
Educational attainment					
Less than 9th grade	1.5	4.5	12.7	31.1	4.0
9th-11th grade	9.8	8.1	41.8	46.6	13.0
High school graduate	25.1	16.7	49.3	51.7	34.2
Some college/associate's degree	50.5	33.1	67.9	56.3	52.6
Bachelor's +	63.4	48.7	76.9	50.5	69.1
Employment	00.4	40.7	70.0	00.0	00.1
Employed	49.8	30.8	66.5	43.6	43.2
Full time	51.4	30.6	69.4	37.6	49.6
Part time	41.9	31.4	68.0	57.5	28.1
		22.1	67.0		NA
Unemployed	17.5			51.0	
Not in labor force	11.5	16.1	52.1	62.9	NA
	20.0	22.0	60.6	NI A	AE E
Not enrolled	32.8	23.9	63.6	NA 10.0	45.5
Below college	47.9	22.0	71.8	46.3	11.9
College	74.7	47.4	77.7	54.6	53.0

Appendix table 8-9. Adult use of computers at home, school, and work: 1993 (Percentages)

Characteristic	Uses computer anywhere	Has computer at home	Has computer at home and uses computer at home	Enrolled in school and uses computer at school	Has a job and uses computer at work
Family income					
Less than \$10,000	11.4	6.8	68.6	53.6	18.3
\$10,000-\$14,999	15.2	8.4	64.8	55.3	23.7
\$15,000-\$19,999	23.0	12.5	62.4	50.9	31.7
\$20,000-\$24,999	27.7	15.3	62.3	56.6	36.0
\$25,000-\$34,999	36.5	21.2	64.3	50.9	42.8
\$35,000-\$49,999	46.3	31.3	55.4	51.0	50.6
\$50,000-\$74,999	60.3	45.9	67.1	54.4	61.5
\$75,000 and over	65.4	61.7	68.0	58.8	67.0
Income not reported	24.4	20.2	57.2	53.3	39.5
Household size					
1-3 persons	33.7	21.2	69.6	51.9	47.5
4-5 persons	43.1	35.8	62.1	56.0	45.0
6-7 persons	30.4	28.6	52.3	56.2	33.7
8+ persons	17.6	22.1	48.3	49.8	19.5
Occupation					
Management and professional	69.6	47.9	77.0	46.7	67.7
Technical, sales, administration	63.6	31.6	69.2	50.7	65.5
Service	22.4	18.6	54.9	53.5	14.7
Precision, production, craft	26.0	21.6	56.8	44.0	23.2
Operators, labor	18.8	15.2	51.9	47.0	14.9
Farm, forest, fish	14.7	16.7	59.5	62.5	8.5
Never work/NILF/AF	10.7	15.4	50.9	61.8	NA
Industry			00.0	00	
Agriculture	19.1	19.9	64.9	51.3	13.5
Mining	44.7	30.7	64.0	(B)	46.1
Construction	20.2	21.4	57.3	49.1	16.8
Manufacturing	43.0	27.3	69.4	48.6	44.0
Transportation, communications, utilities	48.8	29.9	63.6	46.5	49.4
Wholesale/retail	40.8	25.4	61.8	53.1	37.0
Finance, insurance	74.6	36.0	72.4	38.4	79.3
Services	51.2	35.2	72.6	51.2	48.0
Forest/fisheries	36.1	28.8	(B)	(B)	35.2
Public administrator	70.6	34.1	74.0	32.2	73.7
Never work/NILF/AF	10.7	15.4	50.9	61.8	NA

AF = armed forces; (B) = less than 75,000 persons or 50 sample cases; NA = not applicable; NILF = not in labor force

NOTES: Persons of Hispanic origin may be of any race. The term "uses computer anywhere" means that the individual uses computer at home, at school, and/or at work; the term "with computer at home" means that there is a computer in the household.

SOURCE: U.S. Bureau of the Census, Current Population Survey, October 1993. Available from <http://www.census.gov/population/socdemo/computer/compusea/text.

See figures 8-23 and 8-25.

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Appendix table 8-10.

Commercial banks output per employee: 1967-95

Year	Index	Year	Index
1967	71.2	1981	. 78.7
1968	72.5	1982	. 81.0
1969	71.5	1983	. 87.6
1970	72.3	1984	90.7
1971	75.1	1985	94.6
1972	76.9	1986	97.0
1973	81.7	1987	. 100.0
1974	76.9	1988	. 101.4
1975	77.2	1989	. 99.6
1976	81.4	1990	. 102.6
1977	85.9	1991	. 104.5
1978	86.8	1992	. 106.4
1979	84.5	1993	. 115.5
1980	78.8	1994	. 115.8
		1995	. 121.7

NOTES: Commercial banks are Standard Industrial Classification code 602. Industry Productivity Index: 1987 = 100.

SOURCE: U.S. Bureau of Labor Statistics, Industry Productivity Index, <">http://stats.bls.gov/cgi-bin/dsrv>> (data extracted July 1997).">extracted July 1997).

See figure 8-12.

Appendix table 6-1.

Real gross domestic product, for selected countries: 1960-95
(Billions of 1995 U.S. dollars)

	United			South							Nether-			United
	States	Canada	Japan	Korea	Austria	Belgium	Denmark	France	Germany ^a	Italy	lands	Norway	Sweden	Kingdom
1960	2,433.07	170.88	415.98	36.12	55.01	76.32	43.97	378.74	544.64	345.35	100.42	29.26	70.36	507.23
1961	2,484.81	176.24	476.54	38.23	57.93	80.11	46.56	399.60	569.86	373.69	103.33	31.04	74.36	520.29
1962	2,634.66	188.73	510.18	39.05	59.32	84.29	49.12	426.26	596.43	396.87	107.77	31.88	77.53	527.20
1963	2,747.51	198.52	563.76	42.62	61.74	87.96	49.35	449.05	613.21	419.14	111.33	33.08	81.66	548.05
1964	2,907.69	211.76	638.25	46.74	65.47	94.08	53.76	478.32	654.06	430.86	120.90	34.74	87.23	577.85
1965	3,092.62	225.73	671.01	49.42	67.34	97.43	56.34	501.18	80.689	444.94	127.31	36.58	90.56	592.48
1966	3,292.07	241.05	742.11	55.44	71.14	100.51	57.67	527.31	708.30	471.57	130.87	37.96	92.46	603.68
1967	3,378.13	248.12	822.07	58.71	73.28	104.40	59.64	552.03	706.12	505.42	137.81	40.34	95.57	617.52
1968	3,537.77	261.40	927.04	65.36	76.56	108.79	62.01	575.54	744.63	538.50	147.04	41.25	99.05	642.68
1969	3,644.70	275.40	1,040.77	74.42	81.36	116.01	65.93	615.77	800.18	571.34	157.04	43.11	104.01	655.93
1970	3,644.92	282.55	1,142.86	80.94	87.16	123.39	67.26	651.06	840.49	601.68	166.07	43.97	110.74	670.90
1971	3,765.30	298.82	1,193.03	87.81	91.61	127.92	90.69	682.20	866.19	613.08	173.46	45.98	111.79	684.23
1972	3,969.91	315.94	1,293.40	92.04	97.30	134.68	72.70	712.43	903.01	631.02	178.85	48.36	114.34	708.19
1973	4,197.97	340.31	1,397.29	103.82	102.06	142.64	75.34	751.19	946.04	672.30	187.88	50.34	118.88	760.31
1974	4,182.80	355.29	1,380.17	112.20	106.08	148.47	74.64	774.55	947.89	703.83	195.49	52.96	122.68	747.39
1975	4,157.95	364.53	1,422.84	119.64	105.70	146.26	74.15	772.39	936.02	688.72	195.78	55.17	125.82	742.01
1976	4,390.32	386.99	1,479.40	133.72	110.53	154.41	78.95	805.17	985.85	733.47	205.11	58.92	127.15	762.61
1977	4,603.54	400.98	1,544.35	147.51	115.55	155.15	80.23	831.07	1,013.90	754.67	209.90	61.03	125.12	780.63
1978	4,834.18	419.32	1,625.77	161.36	115.62	159.39	81.41	858.92	1,044.29	782.80	214.85	63.80	127.31	807.61
1979	4,974.35	435.55	1,714.93	172.87	121.10	162.79	84.30	886.76	1,088.41	827.21	219.63	67.04	132.20	830.20
1980	4,961.34	442.02	1,763.25	168.23	124.64	169.82	83.92	901.16	1,099.08	856.42	222.28	98.69	134.40	812.25
1981	5,082.90	458.25	1,819.15	178.67	124.28	167.06	83.18	911.76	1,100.17	860.48	221.16	70.47	134.39	801.77
1982	4,973.92	443.51	1,874.76	192.23	125.61	169.83	85.69	934.97	1,089.82	864.42	218.58	70.70	135.73	815.63
1983	5,174.45	457.54	1,918.30	214.33	128.11	170.08	87.85	941.47	1,108.99	874.95	222.32	73.98	138.11	845.62
1984	5,527.51	486.40	1,993.44	232.93	129.85	173.81	91.70	953.84	1,140.20	897.42	229.63	78.23	143.70	865.27
1985	5,733.31	509.59	2,081.24	248.18	133.05	175.10	95.64	971.79	1,163.35	922.64	236.70	82.36	146.47	897.76
1986	5,905.86	526.49	2,141.50	276.86	134.62	177.96	99.12	996.26	1,190.63	948.84	243.22	85.80	149.83	936.21
1987	6,076.37	548.42	2,230.56	308.75	136.85	181.74	99.41	1,018.68	1,208.23	978.22	246.66	87.51	154.55	981.27
1988	6,307.12	575.73	2,368.74	343.55	142.41	190.69	100.57	1,064.50	1,253.21	1,016.06	253.11	87.07	158.03	1,030.37
1989	6,519.59	589.81	2,483.18	365.48	147.86	197.26	101.14	1,109.77	1,298.64	1,045.35	264.96	87.86	161.78	1,052.86
1990	6,603.82	588.43	2,609.42	400.23	154.14	204.52	102.58	1,137.60	1,372.71	1,067.96	275.84	89.50	163.99	1,057.04
1991	6,539.60	577.91	2,713.01	436.78	158.52	207.74	103.96	1,146.48	1,441.98	1,080.12	282.11	92.29	162.16	1,036.31
1992	6,717.53	582.33	2,741.60	458.91	161.75	211.25	104.20	1,159.81	1,467.42	1,086.22	287.82	95.31	159.85	1,030.82
1993	6,870.29	595.26	2,745.11	485.30	162.34	208.39	105.74	1,144.38	1,438.83	1,073.67	290.05	97.95	156.30	1,052.18
1994	7,109.43	619.49	2,758.25	526.93	167.29	213.27	110.38	1,176.72	1,470.80	1,096.49	299.85	102.88	161.52	1,092.55
1995	7,253.80	633.90	2,781.74	574.11	170.34	217.39	113.45	1,202.09	1,494.22	1,129.04	306.27	106.24	167.29	1,119.85

NOTE: Country gross domestic products were determined with 1993 purchasing power parities using the Elteto-Köves-Szulc (EKS) aggregation method, which is the method used by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT in their official statistics. For a discussion of the properties of this aggregation method, see OECD, Purchasing Power Parities and Real Expenditures, 1993: Volume 1, EKS Results (Paris: 1995), p. 4.

SOURCE: U.S. Bureau of Labor Statistics, Office of Productivity and Technology, "Comparative Real Gross Domestic Product Per Capita and Per Employed Person, Fourteen Countries, 1960-1995" (Washington, DC: April 1997).

See figure 6-1.

^aGerman data are for the former West Germany only.

Science & Engineering Indicators - 1998

Appendix table 6-2. **Real gross domestic product per capita, for selected countries: 1960-95** (1995 U.S. dollars)

United States	Canada	Japan	South Korea	Austria	Belgium	Denmark	France	Germany ^a	Italy	Nether- lands	Norway	Sweden	United Kingdom
13,460 13,523	9,542 9,646	4,460 5,065	1,444	7,806 8,175	8,338 8,723	9,598 10,094	8,290	9,825 10,144	7,053	8,745 8,879	8,170 8,599	9,406	9,685
14,120 14,514	10,139	5,371	1,473	8,320 8,604	9,141	10,571	9,070	10,494	8,007	9,132	8,760	10,253	9,893
15,150	10,958	6,587	1,670	9,063	10,032	11,389	9,897	11,282	8,542	9,971	9,404	11,386	10,703
15,913	11,471	6,851	1,722	9,262	10,294	11,843	10,275	11,755	8,752	10,356	9,824	11,710	10,901
16,745	12,024	7,507	1,883	9,716	10,549	12,021	10,721	11,975	9,206	10,508	10,113	11,842	11,048
16,997	12,156	8,227	1,948	9,934	10,897	12,325	11,13/	11,910	9,783	10,940	10,654	12,147	11,236
17,978	13,097	3,172 10,172	2,359	10,934	12,027	13,474	12,238	13,322	10,908	12,199	11,194	13,050	11,827
17,772	13,250	11,019	2,510	11,672	12,786	13,647	12,823	13,858	11,402	12,743	11,339	13,769	12,060
18,129	13,566	11,389	2,670	12,214	13,225	13,915	13,311	14,134	11,541	13,147	11,781	13,804	12,234
18,911	14,178	12,181	2,747	12,897	13,871	14,564	13,780	14,642	11,795	13,417	12,295	14,078	12,624
19,807	15,085	12,859	3,044	13,453	14,646	15,002	14,413	15,265	12,477	13,981	12,711	14,610	13,523
19,555	15,532	12,529	3,234	13,960 13,946	15,200	14,795 14,653	14,764	15,275 15,139	12,940	14,434	13,289	15,034	13,290
20,131	16,456	13,119	3,730	14,610	15,739	15,562	15,218	16,022	13,319	14,892	14,635	15,464	13,566
20,898	16,850	13,561	4,051	15,268	15,796	15,768	15,638	16,513	13,655	15,149	15,095	15,163	13,893
21,714	17,445	14,147	4,365	15,289	16,215	15,951	16,092	17,028	14,118	15,414	15,721	15,383	14,376
22,098	17,941	14,799	4,606	16,041	16,549	16,474	16,542	17,738	14,877	15,650	16,461	15,939	14,762
21,786	17,973	15,096	4,413	16,509	17,245	16,382	16,725	17,852	15,387	15,711	17,098	16,173	14,419
22,099	18,404	15,462	4,614	16,420	16,956	16,239	16,828	17,836	15,428	15,523	17,189	16,151	14,228
21,419	17,598	15,827	4,888	16,580	17,231	16,740	17,158	17,681	15,437	15,273	17,183	16,304	14,483
22,082	17,974	16,085	5,370	16,930	17,258	17,178	17,189	18,055	15,561	15,473	17,920	16,582	14,999
23,383	18,925	16,609	5,765	17,152	17,636	17,939	17,334	18,638	15,928	15,921	18,896	17,238	15,313
24,038	19,644	17,236	6,082	17,557	17,762	18,701	17,578	19,064	16,330	16,338	19,833	17,541	15,838
24,538	20,092	17,627	6,718	17,742	18,045	19,356	17,936	19,497	16,771	16,697	20,588	17,902	16,468
25,022	20,656	18,270	7,418	210,81	18,413	068,61	18,248	19,782	17,264	16,821	20,900	18,403	512,71
25,737	21,407	19,319	8,174	18,700	19,221	19,604	18,969	20,394	17,900	17,148	20,683	18,731	18,027
26,354	21,542	20,169	8,610	19,306	19,849	19,705	19,669	20,924	18,392	17,847	20,785	19,049	18,356
26,420	21,174	21,122	9,336	19,943	20,520	19,954	20,051	21,702	18,757	18,455	21,101	19,160	18,364
25,881	20,551	21,893	10,088	20,289	20,764	20,169	20,094	22,505	18,912	18,722	21,655	18,817	17,927
 26,299	20,403	22,053	10,490	20,440	21,030	20,148	20,215	22,623	18,994	18,958	22,235	18,441	17,771
26,613	20,564	22,019		20,315	20,666	20,380	19,849	21,956	19,035	18,968	22,716	17,927	18,082
27,273	21,175	22,073	11,804	20,834	21,083	21,201	20,323	22,333	19,393	19,495	23,724	18,394	18,710
27,572	21,405	22,210	12,732	21,170	21,445	21,678	20,675	22,586	19,934	19,814	24,371	18,952	19,108

NOTE: Country gross domestic products were determined with 1993 purchasing power parities using the Elteto-Köves-Szulc (EKS) aggregation method, which is the method used by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT in their official statistics. For a discussion of the properties of this aggregation method, see OECD, Purchasing Power Parities and Real Expenditures, 1993: Volume 1, EKS Results (Paris: 1995), p. 4.

SOURCE: U.S. Bureau of Labor Statistics, Office of Productivity and Technology, "Comparative Real Gross Domestic Product Per Capita and Per Employed Person, Fourteen Countries, 1960-1995" (Washington, DC: April 1997).

See figure 6-1.

^aGerman data are for the former West Germany only.

Real gross domestic product per employed person, for selected countries: 1960-95 (1995 U.S. dollars) Appendix table 6-3.

NA 17219 21,993 21,664 19,190 20,897 NA 17,290 22,916 22,607 20,249 21,564 NA 18,571 23,744 23,493 21,605 22,495 NA 18,573 23,931 26,756 25,915 22,579 23,069 NA 18,573 23,931 26,756 25,915 26,591 26,756 NA 18,735 23,931 28,706 26,826 27,514 25,756 25,91 26,755 NA 17,140 25,329 29,945 27,582 28,337 28,833 NA 17,140 33,551 39,020 31,720 36,077 35,916 NA 19,650 34,881 41,409 31,720 36,077 35,973 NA 19,65 38,535 45,389 34,360 40,481 40,967 NA 11,662 37,562 43,389 34,360 40,481 40,967 NA 11,662 37,562 43,389 34,360 40,481 40,967 NA 11,562 41,049 48,468 37,131 44,011 43,365 42,244 43,369 44,473 51,562 44,373 36,994 43,068 46,973 44,973 44,985 46,991 44,049 38,489 46,807 44,664 46,373 20,389 39,418 44,696 46,373 20,389 39,418 44,699 38,738 46,890 48,481 46,890 38,490 48,481 46,890 38,490 39,690 30,490 3	United	Canada	Japan	South	Austria	Belainm	Denmark	France	Germanv ^a	Italy	Nether- lands	Norway	Sweden	United
NA 17,219 21,993 21,664 19,190 20,897 NA 17,290 22,916 22,607 20,249 21,564 NA 17,990 22,916 22,607 20,249 21,564 NA 5,993 20,663 26,946 23,315 22,579 23,099 NA 6,022 21,339 26,766 25,613 24,887 23,789 24,585 NA 6,022 21,339 26,766 25,613 24,887 23,789 24,585 NA 7,405 22,329 29,945 27,582 28,337 28,833 NA 7,905 26,936 31,398 29,045 27,582 28,337 28,833 NA 7,905 26,936 31,398 29,045 27,582 28,337 28,833 NA 8,777 31,495 33,477 38,057 31,718 35,044 32,481 NA 9,684 33,474 39,020 31,527 35,864 34,953 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,584 34,387 34,387 34,387 34,389 34,387 40,481 40,967 NA 12,741 33,406 42,771 40,967 41,966 42,272 49,011 38,194 43,965 42,272 49,011 38,194 44,381 44,012 44,395 18,879 42,991 49,805 31,778 44,973 43,910 42,771 40,925 41,401 48,776 42,272 49,011 38,194 43,985 46,807 44,473 51,509 38,699 48,488 37,738 46,807 44,473 51,509 38,699 48,488 37,738 46,807 44,606 46,373 20,366 44,473 51,509 38,699 48,488 37,738 46,807 44,696 46,373 20,366 44,473 51,509 38,699 48,488 47,103 54,499 55,563 41,510 51,921 49,819 50,897 52,206 48,289 55,400 42,701 40,925 51,706 42,201 49,895 51,509 38,699 48,488 47,103 54,499 55,563 41,510 51,921 49,819 50,897 52,206 48,289 55,600 42,701 49,895 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 38,699 48,489 51,509 52,409 52,		۶	1	200	2007			5	9	, tearly	2	1401443		556
NA 17,990 22,916 22,607 20,249 21,564 NA 18,571 23,744 23,439 22,579 23,068 NA 6,562 21,393 26,766 25,613 24,849 25,756 NA 6,582 21,393 26,766 25,613 24,849 25,756 NA 6,582 22,828 27,514 25,776 25,951 26,555 NA 6,582 22,331 22,824 27,365 NA 7,905 26,936 21,398 29,945 27,582 28,337 28,833 NA 7,905 26,936 31,398 29,065 29,862 20,307 28,736 NA 8,723 29,864 34,351 30,057 32,494 32,481 NA 8,720 36,744 33,735 32,494 32,481 NA 1,495 36,024 31,720 36,077 31,718 35,084 34,957 36,070 31,527 35,083 35,451 NA 11,962 36,074 42,871 33,584 39,284 39,965 NA 11,409 36,136 41,774 33,443 38,198 39,198 NA 11,962 36,074 42,871 33,584 39,284 40,871 40,967 NA 12,295 38,535 45,308 34,369 40,481 40,967 NA 12,295 38,535 45,308 34,369 40,481 40,967 NA 12,662 37,562 49,011 38,194 44,337 36,184 44,973 44,337 44,973 44,973 44,973 44,973 44,973 44,973 42,991 49,805 37,938 46,807 42,272 44,337 44,973 56,184 46,895 18,879 42,272 49,011 38,194 44,835 18,879 42,991 49,805 37,938 46,807 46,907 47,37 47,909 38,198 47,103 54,308 47,103 54,308 47,103 54,308 54,309 42,91 49,805 37,938 46,807 46,907 47,907 67,907 40,879 47,37 47,909 38,198 47,103 54,308 47,103 54,308 47,103 54,308 47,103 54,308 47,103 54,308 54,309 48,481 44,973 49,805 54,407 47,509 56,114 49,805 57,909 57,90		တ်	9,545	Ϋ́	17,219	21,993	21,664	19,190	20,897	N A	21,801	19,090	19,461	21,030
NA 18,571 23,744 23,493 21,605 22,492 NA 5,562 19,458 24,604 23,315 22,579 24,586 NA 6,022 21,393 26,766 26,187 23,789 24,586 NA 6,582 22,826 27,514 25,776 25,951 26,555 NA 6,582 22,826 27,514 25,776 25,951 26,555 NA 6,582 22,826 27,514 25,776 25,951 26,555 NA 7,916 25,329 29,945 27,582 28,337 28,833 NA 7,916 25,329 29,945 27,582 28,337 28,833 NA 7,916 25,329 29,945 27,582 28,337 28,833 NA 8,723 29,864 34,351 30,057 32,494 32,481 NA 8,777 38,057 31,718 35,093 33,735 33,727 NA 9,520 32,477 38,057 31,718 35,094 32,481 NA 11,409 36,136 41,774 33,581 39,020 31,727 35,977 35,977 NA 10,650 34,881 41,409 33,178 37,315 38,090 NA 11,409 36,136 41,774 33,584 39,284 39,965 NA 12,295 38,535 45,308 34,389 41,070 40,377 41,076 42,272 44,337 36,194 43,344 44,337 44,011 38,406 45,422 34,517 41,755 40,821 41,076 12,741 38,406 45,422 34,517 41,775 40,421 44,936 35,400 42,701 40,925 41,401 17,866 42,272 44,337 36,194 44,835 18,879 42,291 49,805 37,338 46,807 44,437 44,835 18,809 41,070 40,377 44,995 52,438 44,837 52,438 44,837 52,438 44,837 52,438 44,837 52,438 44,837 52,438 44,837 52,439 52,448 44,837 52,438 44,837 52,438 44,837 52,438 44,837 52,438 44,837 52,438 44,837 52,438 44,837 52,438 52,446 52,438 52,446 52,338 52,446 52,338 52,448	NA 10,791	10,7	91	Ϋ́	17,990	22,916	22,607	20,249	21,564	¥	22,111	19,940	20,401	21,350
5,562 19,458 24,604 23,315 22,579 23,009 NA 6,583 20,663 25,945 24,849 25,755 NA 6,582 22,826 27,514 25,776 26,943 27,755 NA 6,582 22,826 27,614 25,776 26,943 27,365 NA 7,140 25,329 29,945 27,582 28,337 28,833 NA 7,140 25,329 29,945 27,682 28,337 28,833 NA 7,140 25,329 29,945 27,582 28,337 28,833 NA 8,725 28,743 33,368 29,445 31,151 31,645 NA 8,727 38,057 31,728 32,735 33,727 NA 9,844 31,574 30,020 31,720 36,451 NA 10,114 33,541 30,020 31,721 34,953 NA 10,140 4,881 41,774 33,433 34,965 <	•	11,4	21	Ϋ́	18,571	23,744	23,493	21,605	22,492	¥	22,609	20,362	21,155	21,527
5,993 20,663 25,945 24,887 23,789 24,585 NA 6,022 21,393 26,766 25,613 24,849 25,755 NA 6,782 22,392 29,945 27,582 27,387 28,835 NA 6,735 23,931 28,706 27,098 27,099 NA NA 7,905 26,364 37,582 28,337 28,835 NA 7,905 26,364 37,582 28,337 28,833 NA 8,717 31,398 29,065 29,862 30,509 NA 8,717 31,398 29,065 29,862 30,509 NA 8,717 31,495 36,445 31,151 31,645 NA 8,717 31,495 36,243 39,082 33,735 30,593 NA 9,684 33,474 39,020 31,527 35,863 35,735 NA 10,650 34,881 41,409 33,178 37,316 37,317 N	•	12,5	4	5,562	19,458	24,604	23,315	22,579	23,069	Ϋ́	23,041	21,039	22,171	22,324
6,022 21,393 26,766 25,613 24,849 25,755 NA 6,628 22,826 27,514 25,776 25,951 26,555 NA 6,582 22,826 27,345 NA 7,905 26,936 31,398 29,945 27,682 28,337 28,833 NA 7,905 26,936 31,398 29,945 27,582 28,337 28,833 NA 7,905 26,936 31,398 29,945 31,151 31,645 NA 8,723 29,864 34,351 30,095 33,735 33,727 NA 8,717 31,495 36,243 30,993 33,735 33,727 NA 9,684 33,474 39,003 31,720 36,077 35,973 NA 10,144 33,547 39,003 31,720 36,077 35,973 NA 10,650 34,881 41,409 33,178 37,315 38,090 NA 11,902 36,136 41,774 33,443 38,198 39,118 NA 12,295 38,535 45,389 34,360 40,481 40,967 NA 12,741 38,406 45,422 34,517 41,755 40,821 41,401 42,776 40,479 47,337 36,184 43,058 42,246 41,401 14,776 40,479 47,337 36,184 43,058 42,246 41,401 16,578 42,272 49,011 38,154 44,917 43,365 42,732 16,578 44,473 51,509 38,609 48,481 45,971 49,985 20,386 44,473 51,509 38,609 48,481 45,917 49,918 20,813 45,469 47,103 54,396 41,154 50,951 49,402 50,176 22,131 46,530 53,649 42,541 51,832 51,832 51,832 51,832 51,832 51,331 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,463 51,300 52,462 53,841 52,460 52,460 52,460 52,400	•	13,6	090	5,993	20,663	25,945	24,887	23,789	24,585	Ϋ́	24,590	22,023	23,348	23,235
6,582 22,826 27,514 25,776 25,951 26,555 NA 6,736 27,340 25,329 29,945 27,582 27,998 27,365 NA 7,905 26,332 39,3245 27,582 28,337 28,833 NA 7,905 26,936 31,358 29,445 31,151 31,645 NA 8,72 29,864 34,351 30,057 32,494 32,481 NA 8,717 31,495 36,243 30,993 33,735 33,727 NA 9,824 33,474 39,020 31,527 35,684 34,953 NA 10,114 33,551 39,020 31,720 36,077 35,973 NA 10,650 34,881 41,409 33,178 37,315 38,090 NA 11,962 36,074 42,871 33,544 38,198 39,118 NA 11,962 36,074 42,871 33,544 38,198 39,118 NA 12,741 38,406 45,422 34,517 41,775 40,479 47,375 35,184 43,058 42,272 49,011 38,154 44,973 44,917 44,011 44,011 44,049 48,468 37,131 44,011 44,336 42,246 41,826 16,778 44,973 47,378 35,184 45,924 44,973 44,985 18,879 42,991 49,865 37,778 44,973 44,966 46,925 18,879 42,991 49,860 48,481 45,971 48,042 20,813 45,499 52,463 39,044 49,885 46,963 51,592 22,131 46,530 53,624 40,002 50,611 48,201 49,965 23,468 47,103 54,397 41,510 51,221 44,66 53,844 51,826 22,448 57,103 54,397 41,510 51,221 49,603 51,592 22,206 48,289 55,409 42,577 44,666 53,841 50,897 22,206 48,289 55,409 42,577 44,666 53,841 50,897 22,206 48,289 55,409 42,577 44,666 53,841 50,897 22,206 48,289 55,409 42,577 44,666 53,841 50,897 22,206 48,289 55,409 57,100 50,611 48,201 49,965 22,468 47,103 54,397 44,596 51,201 53,841 50,897 52,656 44,789 57,106 53,843 52,462 55,841		14,4	52	6,022	21,393	26,766	25,613	24,849	25,755	Υ Σ	25,675	22,996	24,074	23,586
6,736 23,931 28,706 26,826 27,098 27,365 NA 7,140 25,329 29,945 27,582 28,337 28,833 NA 7,905 29,945 27,582 28,337 28,833 NA 8,723 29,864 34,351 30,057 32,494 32,481 NA 9,884 33,474 39,020 31,527 35,984 34,953 NA 9,684 33,474 39,020 31,527 35,983 37,27 NA 9,684 33,474 39,020 31,720 36,077 35,973 NA 11,962 36,074 42,817 33,544 39,284 39,965 NA 11,962 36,074 42,818 34,198 39,118 NA 11,962 36,074 42,819 34,360 40,481 40,967 NA 12,295 38,535 45,704 42,819 37,315 40,825 41,401 14,776 40,479 47,377 36,184 43,058 42,246 41,326 16,578 41,966 48,573 36,184 43,058 42,246 41,401 17,866 42,272 49,011 38,178 44,973 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,807 44,666 46,373 25,208 41,103 54,308 41,154 50,951 49,805 51,609 25,403 51,509 25,403 51,201 49,805 51,201 49,885 46,807 42,901 49,805 52,463 39,044 49,885 46,953 51,509 25,403 41,154 50,746 57,377 45,166 53,843 51,310 53,841 52,403 51,592 52,208 48,289 52,403 51,310 53,841 52,403 51,310 53,841 52,403 51,310 53,841 52,403 51,310 53,841		15,6	46	6,582	22,826	27,514	25,776	25,951	26,555	Υ Σ	26,190	23,761	24,543	23,975
7,140 25,329 29,945 27,582 28,337 28,833 NA 7,905 26,936 31,398 29,065 29,862 30,509 NA 8,305 28,743 33,368 29,065 29,862 30,509 NA 8,723 29,864 34,351 30,057 32,481 NA 9,684 34,351 30,057 32,481 NA 9,684 33,474 39,003 31,720 35,671 34,551 NA 10,114 33,551 39,003 31,720 36,077 35,973 NA 10,650 34,881 41,409 33,178 37,315 38,090 NA 11,409 36,136 41,774 33,443 39,18 39,18 NA 11,409 36,136 41,774 33,483 34,369 41,070 A0,737 NA 12,652 37,562 45,308 34,369 41,070 40,737 NA 12,741 38,074 42,87	•	16,9	81	6,735	23,931	28,706	26,826	27,098	27,365	Ϋ́	27,664	25,074	25,643	24,810
7,905 26,936 31,398 29,065 29,862 30,509 NA 8,305 28,743 33,368 29,445 31,151 31,645 NA 8,723 29,864 34,351 30,057 32,494 32,481 NA 8,717 31,495 36,243 30,093 33,735 33,727 NA 9,320 32,477 38,057 31,728 35,451 NA 10,114 33,551 39,003 31,720 36,074 34,881 NA 10,650 34,881 41,409 33,178 37,315 38,996 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,484 39,284 39,965 NA 11,962 36,074 42,871 33,489 39,118 NA 12,524 43,389 34,360 40,481 40,967 NA 12,741 38,406 40,481 40,967		18,7	93	7,140	25,329	29,945	27,582	28,337	28,833	Ϋ́	29,246	25,608	26,297	25,946
8,305 28,743 33,368 29,445 31,151 31,645 NA 8,723 29,864 34,351 30,057 32,494 32,481 NA 8,723 29,864 34,351 30,057 32,494 32,481 NA 9,320 32,477 38,057 31,718 35,084 34,953 NA 10,650 34,881 41,409 31,724 35,673 35,973 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,584 39,284 39,965 NA 12,052 37,562 43,389 34,369 41,070 40,377 NA 12,741 38,406 45,422 34,517 41,755 40,821 41,007 12,741 38,406 45,422 34,517 41,755 40,821 41,007 12,741 38,406 45,422 34,517 41,755 40,821 41,007 14,007 47,337 36,184 43,058 42,246 41,826 16,143 41,049 47,337 36,184 42,071 42,336 42,772 49,011 38,154 45,924 44,334 44,835 16,789 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 49,965 20,813 45,499 52,463 39,044 49,885 46,963 51,509 22,131 46,530 53,624 40,002 50,611 48,201 49,965 22,131 46,530 53,624 40,002 50,611 48,201 49,965 22,131 46,530 53,624 41,66 53,843 52,462 53,841 52,462 53,843	NA 20,895	20,8	32	7,905	26,936	31,398	29,065	29,862	30,509	¥	30,723	26,530	27,104	26,481
8,723 29,864 34,351 30,057 32,494 32,481 NA 8,717 31,495 36,243 30,993 33,735 33,727 NA 9,320 32,477 38,057 31,718 35,084 34,953 NA 10,144 33,551 39,003 31,720 35,077 35,973 NA 10,650 34,881 41,409 33,178 35,315 39,010 NA 11,962 36,074 42,817 33,584 39,284 39,965 NA 12,741 38,406 45,422 34,517 41,775 40,479 47,337 36,184 43,058 42,246 41,070 40,737 NA 12,295 38,535 45,308 34,360 40,481 40,967 NA 12,776 40,479 47,337 36,184 43,058 42,246 41,826 16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,918 44,835 16,578 42,297 49,011 38,154 45,924 44,334 44,835 17,856 42,272 49,011 38,154 45,924 44,334 44,835 20,813 45,499 52,463 39,044 49,885 46,953 49,472 52,131 46,530 53,624 41,510 51,921 49,805 52,403 41,510 51,921 49,803 51,708 52,403 41,510 51,832 51,310 53,587 52,206 48,289 55,409 42,541 51,832 51,310 53,587 52,206 48,289 55,409 42,541 51,832 52,462 55,841 50,746 57,977 45,166 53,843 52,462 55,841		22,68	35	8,305	28,743	33,368	29,445	31,151	31,645	Α	32,109	26,631	28,305	27,162
8,717 31,495 36,243 30,993 33,735 33,727 NA 9,320 32,477 38,057 31,718 35,084 34,953 NA 10,114 33,551 39,003 31,720 36,077 35,973 NA 10,114 33,551 39,003 31,720 36,077 35,973 NA 11,409 36,174 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,584 39,284 39,965 NA 11,962 37,562 43,389 34,360 40,481 40,967 NA 12,295 38,535 45,308 34,369 41,070 40,737 NA 12,295 38,535 45,308 34,369 41,070 40,737 NA 12,741 38,406 45,782 35,131 44,011 43,369 41,076 41,376 40,479 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,918 44,835 16,578 42,291 49,805 37,778 44,973 43,918 44,835 16,578 42,991 49,805 37,938 46,807 44,666 46,373 20,813 45,499 52,463 39,044 49,885 46,953 49,472 52,206 44,473 55,409 42,541 49,885 46,953 52,463 49,693 57,106 44,666 53,843 52,462 55,841 50,746 57,977 45,166 53,843 52,462 55,841		23,52	9	8,723	29,864	34,351	30,057	32,494	32,481	Ϋ́	33,339	27,597	28,628	28,111
9,320 32,477 38,057 31,718 35,084 34,953 NA 9,884 33,474 39,020 31,527 35,863 35,451 NA 10,114 33,551 39,003 31,720 36,077 35,973 NA 10,114 33,551 39,003 31,720 36,077 35,973 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,584 39,284 39,965 NA 12,652 37,562 43,389 34,360 40,481 40,967 NA 12,741 38,535 45,308 34,369 41,070 40,737 NA 12,741 38,406 45,823 36,184 43,058 42,246 41,826 14,776 40,479 48,468 37,131 44,011 43,365 42,732 16,78 44,973 44,935 16,78 42,272 49,011 38,154 45,924 44,334 44,835 16,578 42,291 49,805 37,778 44,973 43,918 44,835 16,578 42,291 49,805 37,778 44,973 43,918 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 41,154 50,746 57,97 43,66 53,843 52,663 49,693 57,106 44,666 53,843 52,462 55,841		25,45	_	8,717	31,495	36,243	30,993	33,735	33,727	¥	34,675	28,712	29,187	28,917
9,684 33,474 39,020 31,527 35,863 35,451 NA 10,114 33,551 39,003 31,720 36,077 35,973 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 37,562 45,308 34,369 41,070 40,737 NA 12,295 38,535 45,308 34,369 41,070 40,737 NA 12,741 38,406 45,422 34,517 41,755 40,821 41,076 13,369 39,318 46,785 35,400 42,701 40,925 41,401 44,776 40,479 48,468 37,131 44,011 43,365 42,732 16,78 41,956 48,557 37,778 44,973 43,918 43,810 17,856 42,272 49,011 38,154 45,924 44,334 44,835 16,578 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,955 46,953 49,472 22,131 46,530 53,624 41,510 51,921 49,805 51,708 22,131 46,530 53,624 41,510 51,921 49,803 51,708 22,206 48,289 55,409 42,541 51,832 51,310 53,587 22,206 48,289 55,409 42,641 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841		26,79	<u>ල</u>	9,320	32,477	38,057	31,718	35,084	34,953	¥	36,410	29,696	30,232	30,449
10,114 33,551 39,003 31,720 36,077 35,973 NA 10,650 34,881 41,409 33,178 37,315 38,090 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,584 39,284 39,965 NA 12,652 37,562 43,389 34,360 40,481 40,967 NA 12,295 38,535 45,308 34,369 41,755 40,827 NA 12,741 38,406 45,422 34,517 41,755 40,925 41,401 14,776 40,479 48,468 37,131 44,011 43,365 42,745 41,956 48,557 37,778 44,973 43,918 43,810 17,856 42,272 49,011 38,154 45,924 44,334 44,835 16,578 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 41,154 50,746 57,977 43,935 51,310 53,587 25,506 48,299 55,409 42,541 51,832 49,693 57,106 42,646 53,384 52,462 55,841		26,56	7	9,684	33,474	39,020	31,527	35,863	35,451	¥	37,521	30,836	30,592	29,860
10,650 34,881 41,409 33,178 37,315 38,090 NA 11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,584 39,284 39,965 NA 12,652 37,562 43,389 34,360 40,481 40,967 NA 12,295 38,535 45,308 34,360 40,481 40,967 NA 12,741 38,406 45,422 34,517 41,755 40,821 41,076 13,369 39,318 46,785 35,400 42,701 40,925 41,401 14,776 40,479 48,488 37,131 44,011 43,365 42,272 49,011 38,154 45,924 44,334 44,835 16,578 42,991 49,805 37,938 46,807 44,666 46,373 20,813 45,499 52,463 39,044 49,885 46,965 46,975 49,472 22,131 46,530 53,624 40,002 50,611 48,201 49,955 22,131 46,530 53,624 40,002 50,611 48,201 49,955 22,131 46,530 53,634 41,154 50,746 57,977 45,166 53,843 52,462 55,841		27,48	₩.	10,114	33,551	39,003	31,720	36,077	35,973	¥	37,869	31,512	30,766	29,799
11,409 36,136 41,774 33,443 38,198 39,118 NA 11,962 36,074 42,871 33,584 39,284 39,965 NA 12,652 37,562 43,389 34,360 40,481 40,967 NA 12,295 38,535 45,308 34,369 41,070 40,737 NA 12,776 40,479 47,337 35,184 43,058 42,246 41,826 16,143 41,049 48,567 37,778 44,973 43,918 43,810 17,856 42,272 49,011 38,154 45,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 22,131 46,530 53,624 40,002 50,611 48,201 49,965 22,131 46,530 53,624 40,002 50,611 48,201 49,965 22,131 46,530 53,624 40,002 50,611 48,201 49,965 22,131 46,530 53,624 41,154 50,951 49,803 57,106 42,240 51,807 42,91 49,805 51,921 49,805 51,310 53,887 22,663 49,693 57,106 53,843 52,462 55,841 50,746 57,977 45,166 53,843 52,462 55,841		28,308		10,650	34,881	41,409	33,178	37,315	38,090	Ϋ́	39,445	32,572	30,985	30,875
11,962 36,074 42,871 33,584 39,284 39,965 NA 12,652 37,562 43,389 34,360 40,481 40,967 NA 12,295 38,535 45,308 34,369 41,070 40,737 NA 12,741 38,406 45,422 34,517 41,755 40,821 41,076 14,776 40,479 47,337 36,184 43,058 42,246 41,826 16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,318 43,810 17,856 42,272 49,011 38,154 45,973 43,318 43,810 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 46,499 55,463 41,154 50,746 48,289 55,409 42,541 51,822 49,603 51,592 26,563 49,693 57,106 44,666 53,843 52,462 55,841		29,16	_	11,409	36,136	41,774	33,443	38,198	39,118	¥	39,529	32,896	30,429	31,566
12,595 37,562 43,389 34,360 40,481 40,967 NA 12,295 38,535 45,308 34,369 41,070 40,737 NA 12,741 38,406 45,422 34,517 41,755 40,821 41,076 13,369 39,318 46,785 35,400 42,701 40,925 41,401 14,776 40,479 47,337 36,184 43,058 42,246 41,826 16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,918 43,810 17,856 42,272 49,011 38,154 45,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 49,881 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 40,002 50,611 48,201 49,955 23,468 47,103 55,563 41,154 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,666 53,843 52,462 55,841		30,32	9	11,962	36,074	42,871	33,584	39,284	39,965	Ϋ́	40,084	33,784	30,846	32,395
12,295 38,535 45,308 34,369 41,070 40,737 NA 12,741 38,406 45,422 34,517 41,755 40,821 41,076 13,369 39,318 46,785 35,400 42,701 40,925 41,401 14,776 40,479 47,337 36,184 43,058 42,246 41,826 16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,318 43,810 17,856 42,272 49,011 38,154 45,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,813 45,499 52,463 39,044 49,885 46,953 49,472 20,813 46,530 53,624 40,002 50,651 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,40 50,897	40,199 31,594	31,59	4	12,652	37,562	43,389	34,360	40,481	40,967	¥	40,226	34,956	31,571	32,879
12,741 38,406 45,422 34,517 41,755 40,821 41,076 13,369 39,318 46,785 35,400 42,701 40,925 41,401 14,776 40,479 47,337 36,184 43,058 42,246 41,826 16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,918 43,810 17,866 42,272 49,011 38,154 45,924 44,835 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,953 49,472 20,813 46,499 53,624 40,002 50,611 48,201 49,955 22,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,403 51,592 <td></td> <td>32,15</td> <td>က္လ</td> <td>12,295</td> <td>38,535</td> <td>45,308</td> <td>34,369</td> <td>41,070</td> <td>40,737</td> <td>Ϋ́</td> <td>39,482</td> <td>35,621</td> <td>31,746</td> <td>32,503</td>		32,15	က္လ	12,295	38,535	45,308	34,369	41,070	40,737	Ϋ́	39,482	35,621	31,746	32,503
13,369 39,318 46,785 35,400 42,701 40,925 41,401 14,776 40,479 47,337 36,184 43,058 42,246 41,826 16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,318 42,732 17,856 42,272 49,011 38,154 45,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,813 45,499 52,463 39,044 49,885 46,953 49,472 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,168 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,402 50,176 25,206 48,289 55,409 42,541 51,832 51,802 56,891 <td></td> <td>32,86</td> <td>9</td> <td>12,741</td> <td>38,406</td> <td>45,422</td> <td>34,517</td> <td>41,755</td> <td>40,821</td> <td>41,076</td> <td>39,073</td> <td>35,587</td> <td>31,690</td> <td>33,227</td>		32,86	9	12,741	38,406	45,422	34,517	41,755	40,821	41,076	39,073	35,587	31,690	33,227
14,776 40,479 47,337 36,184 43,058 42,246 41,826 16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,918 43,810 17,856 42,272 49,011 38,154 46,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,813 45,499 52,463 39,044 49,885 46,953 49,472 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 40,002 50,611 48,995 50,176 24,203 47,849 55,563 41,154 50,951 49,402 50,176 25,206 48,289 55,409 42,541 51,921 49,819 50,897 26,563 49,693 57,106 44,664 53,335 51,310 53,587 <td></td> <td>33,56</td> <td>2</td> <td>13,369</td> <td>39,318</td> <td>46,785</td> <td>35,400</td> <td>42,701</td> <td>40,925</td> <td>41,401</td> <td>38,824</td> <td>35,651</td> <td>32,069</td> <td>34,155</td>		33,56	2	13,369	39,318	46,785	35,400	42,701	40,925	41,401	38,824	35,651	32,069	34,155
16,143 41,049 48,468 37,131 44,011 43,365 42,732 16,578 41,956 48,557 37,778 44,973 43,918 43,810 17,856 42,272 49,011 38,154 46,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,866 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,957 49,472 22,131 46,530 53,624 40,002 50,611 48,042 50,176 23,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,587		33,77	62	14,776	40,479	47,337	36,184	43,058	42,246	41,826	40,275	37,437	32,556	35,575
16,578 41,956 48,557 37,778 44,973 43,918 43,810 17,856 42,272 49,011 38,154 45,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 40,002 50,611 48,201 49,955 23,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,97 45,166 53,843 52,462 55,841 <td>42,381 34,905</td> <td>34,9</td> <td>02</td> <td>16,143</td> <td>41,049</td> <td>48,468</td> <td>37,131</td> <td>44,011</td> <td>43,365</td> <td>42,732</td> <td>41,079</td> <td>39,346</td> <td>33,594</td> <td>35,814</td>	42,381 34,905	34,9	02	16,143	41,049	48,468	37,131	44,011	43,365	42,732	41,079	39,346	33,594	35,814
17,856 42,272 49,011 38,154 45,924 44,334 44,835 18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 40,002 50,611 48,291 49,472 24,203 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841		36,1	92	16,578	41,956	48,557	37,778	44,973	43,918	43,810	41,165	40,339	33,893	36,688
18,879 42,991 49,805 37,938 46,807 44,666 46,373 20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 40,002 50,611 48,201 49,955 23,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841		36,9	335	17,856	42,272	49,011	38,154	45,924	44,334	44,835	41,647	40,779	34,457	38,027
20,366 44,473 51,509 38,609 48,481 45,971 48,048 20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 40,002 50,611 48,201 49,955 23,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,887 28,174 50,746 57,977 45,166 53,843 52,462 55,841		38,	060	18,879	42,991	49,805	37,938	46,807	44,666	46,373	41,525	40,752	35,260	38,970
20,813 45,499 52,463 39,044 49,885 46,953 49,472 22,131 46,530 53,624 40,002 50,611 48,201 49,955 23,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841		39,	777	20,366	44,473	51,509	38,609	48,481	45,971	48,048	42,540	40,853	35,565	39,554
22,131 46,530 53,624 40,002 50,611 48,201 49,955 23,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841	44,801 40,882	40,8	382	20,813	45,499	52,463	39,044	49,885	46,953	49,472	43,578	42,420	35,887	39,492
23,468 47,103 54,396 41,154 50,951 49,402 50,176 24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,687 28,174 50,746 57,977 45,166 53,843 52,462 55,841		42,	121	22,131	46,530	53,624	40,002	50,611	48,201	49,955	43,509	43,569	36,043	39,368
24,203 47,849 55,563 41,510 51,921 49,819 50,897 25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841		42,	42,955	23,468	47,103	54,396	41,154	50,951	49,402	50,176	43,738	45,272	36,183	39,508
25,206 48,289 55,409 42,541 51,832 49,603 51,592 26,563 49,693 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841		42,	42,931	24,203	47,849	55,563	41,510	51,921	49,819	20,897	43,281	46,888	37,330	39,939
26,563 49,693 57,106 44,664 53,335 51,310 53,587 28,174 50,746 57,977 45,166 53,843 52,462 55,841		42,8	42,859	25,206	48,289	55,409	42,541	51,832	49,603	51,592	43,157	48,093	38,516	41,085
28.174 50.746 57.977 45.166 53.843 52.462 55.841		43,0	30	26,563	49,693	57,106	44,664	53,335	51,310	53,587	44,554	49,930	40,209	42,298
	46,693 43,377	43,3	22	28,174	50,746	57,977	45,166	53,843	52,462	55,841	44,776	50,511	41,013	43,137

NA = not available

NOTE: Country gross domestic products were determined with 1993 purchasing power parities using the Elteto-Köves-Szulc (EKS) aggregation method, which is the method used by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT in their official statistics. For a discussion of the properties of this aggregation method, see OECD, Purchasing Power Parities and Real Expenditures, 1993: Volume 1, EKS Results (Paris: 1995), p. 4.

^aGerman data are for the former West Germany only.

SOURCE: U.S. Bureau of Labor Statistics, Office of Productivity and Technology, "Comparative Real Gross Domestic Product Per Capita and Per Employed Person, Fourteen Countries, 1960-1995" (Washington, DC: April 1997).

See figure 6-1.

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Air	Aircraft	Communications	cations	Office & computers	mputers	Drugs & medicines	adicines	High-tech manufacturing	ınufacturing	Other manufacturing	facturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						United States	States							
1970	249,584.0	39.9	N	N A	6,664.1	46.3	3,233.6	44.0	3,425.6	51.6	N A	Υ Y	AN	Ą
1971	263,018.0	40.0	10,495.9	¥	6,992.5	47.8	3,072.0	48.3	3,795.8	53.3	24,356.2	86.7	AN	Ą
1972	290,424.0	38.9	11,234.4	47.9	7,528.8	45.6	3,620.5	45.5	4,465.2	56.9	26,848.9	48.1	263,575.1	38.2
1973	323,403.0	37.4	12,165.5	42.1	8,796.2	44.3	4,022.8	44.5	4,736.4	54.2	29,721.0	44.7	293,682.0	36.8
1974	337,278.0	33.3	12,819.4	45.6	7,062.3	35.2	4,451.3	45.6	4,668.2	46.8	29,001.3	41.5	308,276.8	32.7
1975	354,689.0	34.8	13,172.8	41.3	8,791.1	43.7	4,827.9	55.9	5,408.9	49.5	32,200.7	45.0	322,488.3	34.1
1976	405,313.0	34.7	14,018.4	44.0	9,900.5	45.9	5,536.7	43.3	6,408.5	50.4	35,864.0	44.6	369,449.0	34.0
1977	462,365.0	34.5	15,814.7	47.0	12,683.5	43.4	6,661.2	40.4	6,728.6	47.7	41,888.0	44.8	420,477.0	33.8
1978	516,936.0	34.4	18,499.0	45.1	14,580.6	45.6	8,246.0	40.9	7,427.8	46.2	48,753.4	43.7	468,182.6	33.6
1979	571,281.0	33.5	20,217.6	37.7	15,332.4	38.4	9,853.0	38.3	8,099.3	48.1	53,502.2	39.3	517,778.8	33.0
1980	584,406.0	32.1	20,083.8	32.8	19,821.6	41.8	11,959.5	38.4	9,352.2	48.1	61,217.1	38.4	523,188.9	31.5
1981	652,014.0	32.7	30,723.8	46.1	23,437.1	44.2	13,745.7	39.1	10,958.3	50.3	78,864.9	44.6	573,149.1	31.6
1982	649,768.0	33.7	33,401.5	46.8	24,414.1	43.2	15,330.3	37.4	12,911.4	53.2	86,057.3	44.6	563,710.7	32.5
1983	690,088.0	33.8	37,898.5	49.4	29,013.1	45.0	17,314.5	37.7	14,703.9	54.2	98,930.0	46.1	591,158.0	32.3
1984	780,524.0	34.3	39,989.5	46.1	36,191.5	43.3	19,856.0	35.1	15,304.0	53.2	111,341.0	43.6	669,183.0	33.2
1985	802,938.0	35.0	43,277.1	45.2	40,016.8	44.5	20,101.8	35.4	17,315.7	22.7	120,711.4	44.1	682,226.6	33.8
1986	833,149.0	36.4	48,064.1	46.4	41,814.8	44.2	18,079.4	34.8	18,691.8	54.1	126,650.1	44.5	706,498.9	35.3
1987	889,047.0	36.4	47,786.5	43.4	48,234.5	51.9	17,187.1	32.5	20,683.6	54.3	133,891.7	45.6	755,155.3	35.1
1988	971,297.0	36.5	49,504.9	43.5	51,642.7	51.6	18,864.1	31.4	23,209.5	54.1	143,221.2	45.2	828,075.8	35.3
1989	1,013,420.0	36.0	51,646.4	43.6	56,792.5	54.1	19,512.1	32.5	25,769.1	53.1	153,720.1	46.3	859,699.9	34.6
1990	1,031,350.0	35.8	53,608.2	41.0	57,367.3	52.6	19,299.1	33.2	29,075.2	55.0	159,349.8	45.4	872,000.2	34.5
1991	1,028,060.0	36.2	47,616.7	36.3	60,357.8	53.1	16,819.8	31.3	33,416.9	52.5	158,211.2	44.1	869,848.8	35.1
1992	1,063,570.0	35.9	45,246.7	35.4	62,524.0	49.2	17,618.3	29.6	36,165.7	55.2	161,554.7	42.5	902,015.3	34.9
1993	1,116,530.0	36.1	39,487.0	32.6	70,890.2	51.1	17,458.4	27.9	38,624.2	56.4	166,459.8	45.6	950,070.2	35.1
1994	1,197,090.0	36.2	NA	Ϋ́	84,507.9	53.9	19,521.9	27.3	40,586.0	55.0	NA	Α	AN AN	ΑN
1995	1,287,710.0	36.2	¥.	¥	Y V	Ϋ́	NA	¥	AN	NA	Y Y	Ϋ́	AN	Ϋ́
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Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Airc	Aircraft	Communications	cations	Office & computers	mputers	Drugs & medicines	edicines	High-tech manufacturing	ınufacturing	Other manufacturing	facturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added Value added value added value added value	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						Jak	Japan							
1970	26,402,200.0	32.8	44,334.4	44.3	1,470,640.0	37.5	312,745.0	36.2	549,674.0	55.8	2,377,393.4	40.5	24,024,806.6	32.2
1971	28,430,200.0	33.8	51,899.5	45.3	1,458,200.0	37.7	327,933.0	38.1	658,130.0	0.09	2,496,162.5	45.0	25,934,037.5	33.1
1972	31,917,900.0	34.3	62,418.6	45.3	1,738,620.0	39.1	365,772.0	39.5	672,480.0	61.4	2,839,290.6	43.0	29,078,609.4	33.7
1973	39,568,100.0	33.5	90,705.1	47.1	1,972,330.0	37.5	449,269.0		704,728.0	28.7	3,217,032.1	40.6	36,351,067.9	32.9
1974	45,137,200.0	30.8	108,524.0	48.5	2,078,780.0	37.0	581,084.0		619,336.0	42.4	3,387,724.0	38.0	41,749,476.0	30.3
1975	44,800,800.0	31.0	121,152.0	49.0	1,972,680.0	38.4	556,282.0	36.9	856,016.0	9.15	3,506,130.0	41.0	41,294,670.0	30.4
1976	51,100,500.0	30.9	133,580.0	49.5	2,618,840.0	36.0	600,145.0	39.5	995,602.0	0.55.0	4,348,167.0	39.9	46,752,333.0	30.2
1977	55,412,200.0	31.2	132,919.0	49.0	2,822,760.0	36.4	726,608.0		1,178,250.0	6.75	4,860,537.0	39.7	50,551,663.0	30.6
1978	60,545,300.0	32.6	148,533.0	49.0	2,928,110.0	36.2	836,794.0		1,502,180.0	67.5	5,415,617.0	41.3	55,129,683.0	32.0
1979	64,815,400.0	31.2	134,096.0	42.8	3,240,990.0	35.4	989,708.0	33.7	1,312,850.0	9.55	5,677,644.0	38.4	59,137,756.0	30.7
1980	70,232,300.0	29.0	153,506.0	44.4	3,932,900.0	33.2	1,179,570.0	33.5	1,476,360.0	52.4	6,742,336.0	36.4	63,489,964.0	28.3
1981	74,938,500.0	29.9	147,224.0	44.6	4,865,830.0	33.3	1,335,990.0	32.4	1,760,620.0	929	8,109,664.0	36.5	66,828,836.0	29.2
1982	78,467,500.0	30.9	176,235.0	42.7	5,393,120.0	35.3	1,542,630.0	34.0	1,928,100.0	622.0	9,040,085.0	38.2	69,427,415.0	30.1
1983	81,747,700.0	31.5	203,000.0	43.8	6,278,730.0	34.8	1,986,090.0		2,093,640.0	28.0	10,561,460.0	37.9	71,186,240.0	30.7
1984	89,244,900.0	31.9	231,453.0	45.0	8,146,470.0	34.7	2,342,440.0		2,046,000.0	0.75	12,766,363.0	36.7	76,478,537.0	31.2
1985	94,672,600.0	32.9	283,397.0	45.1	8,276,160.0	35.3	2,853,440.0		2,107,600.0	9'.29	13,520,597.0	37.8	81,152,003.0	32.2
1986	95,817,400.0	35.0	265,439.0	44.0	8,308,320.0	35.3	2,912,310.0		2,326,180.0		13,812,249.0	38.5	82,005,151.0	34.4
1987	98,406,700.0	36.2	331,277.0	47.6	8,285,500.0	35.6	2,895,760.0		2,478,640.0	61.7	13,991,177.0	38.5	84,415,523.0	35.8
1988	105,000,000.0	35.9	297,266.0	41.4	9,291,270.0	35.2	3,117,800.0		2,526,560.0	00.1	15,232,896.0	37.8	89,767,104.0	35.6
1989	113,000,000.0	35.7	265,123.0	36.2	10,281,900.0	36.0	3,535,620.0	34.9	2,756,460.0	61.2	16,839,103.0	38.4	96,160,897.0	35.3
1990	121,000,000.0	35.6	262,173.0	35.1	10,973,200.0	36.3	3,946,330.0	35.0	2,778,640.0	60.3	17,960,343.0	38.3	103,039,657.0	35.2
1991	129,000,000.0	36.1	276,712.0	37.0	11,580,100.0	35.7	4,218,600.0	34.4	2,864,740.0	2.09	18,940,152.0	37.8	110,059,848.0	35.8
1992	128,000,000.0	37.1	316,265.0	38.9	10,349,400.0	35.5	4,007,420.0	33.7	2,992,610.0	61.4	17,665,695.0	37.8	110,334,305.0	37.0
1993	121,000,000.0	37.1	350,262.0	41.7	9,763,680.0	34.8	3,430,760.0		3,098,270.0	61.8	16,642,972.0	37.2	104,357,028.0	37.1
1994	117,000,000.0	37.2	A V	Ν Α	9,629,530.0	35.5	3,189,820.0	34.2	3,115,700.0	NA	N	¥	NA	NA
1995	120,000,000.0	37.2	₹ Z	N	Y V	¥	A A	NA	AN	ΑΝ	Y Y	Ϋ́	NA	Ν

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

Value added (millions of millions of millions of production nat'l currency) (millions of production production) 1970 259,450.0 40.0 1971 277,210.0 40.2 1972 295,650.0 40.4 1973 332,580.0 40.2 1974 354,320.0 38.0 1975 352,540.0 38.0 1976 352,540.0 37.4 1976 387,270.0 37.4 1976 3414,400.0 37.9		Value added/ production (percent) ^a r 33.7 33.5	Value added Value of	Value added/	Value added V	Value added/	Value added \	Value added/	Value added	Value added/	Value added	Value added/
259,450.0 277,210.0 277,210.0 295,650.0 332,580.0 354,320.0 354,320.0 354,420.0	934.6 1,011.1 1,159.2 1,651.3 1,647.1 1,528.7	ent) ^a 3.7 3.5		Doggorio		production		production	(millions of	production		production
259,450.0 277,210.0 295,650.0 332,580.0 354,320.0 362,540.0 387,270.0	934.6 1,011.1 1,159.2 1,651.3 1,647.1 1,647.1	33.7	\sim		nat'l currency)		nat'l currency)	(percent) ^a	nat'l currency)	(percent) ^a	nat'l currency)	(percent) ^a
259,450.0 277,210.0 295,650.0 332,580.0 354,320.0 352,540.0 387,270.0	934.6 1,011.1 1,159.2 1,651.3 1,647.1 1,528.7	33.7 33.5 37.5		Germany	nany							
277,210.0 295,650.0 332,580.0 354,320.0 352,540.0 387,270.0	1,011.1 1,159.2 1,651.3 1,647.1 1,528.7	33.5	N	NA	4,018.1	79.7	NA	NA	NA	NA	AN	NA
295,650.0 332,580.0 354,320.0 352,540.0 387,270.0	1,159.2 1,651.3 1,647.1 1,528.7	37.5	Ϋ́	¥	4,383.3	80.0	NA	N A	Ϋ́	ΑĀ	ΑN	Ϋ́
332,580.0 354,320.0 352,540.0 387,270.0 414,480.0	1,651.3 1,647.1 1,528.7	9	NA	¥	5,033.5	9.08	NA	N A	Ϋ́	Ν	AN	Ϋ́
354,320.0 352,540.0 387,270.0	1,647.1	42.9	Ϋ́	¥	5,238.3	81.0	NA	N A	Ϋ́	ΑĀ	AN	Ϋ́
352,540.0	1,528.7	38.9	NA	¥	5,311.6	79.6	NA	AN V	Ϋ́	ΑĀ	AN	Ϋ́
387,270.0		39.8	Ϋ́	¥	4,551.5	82.5	5,501.4	48.7	Ϋ́	ΑĀ	ΑN	Ϋ́
0.097.117	1,744.7	45.8	21,028.0	20.0	4,934.4	83.1	6,050.4	47.9	33,757.5	52.4	353,512.5	36.4
0.004,114	1,764.5	46.4	22,689.3	56.3	5,930.0	81.8	6,444.5	46.7	36,828.3	56.5	374,651.7	37.0
1978 435,350.0 38.9	2,491.1	55.0	22,894.1	56.4	5,951.5	81.6	6,993.3	50.4	38,330.1	57.8	397,019.9	37.7
1979 467,080.0 37.7	2,928.2	48.9	23,919.8	54.5	6,130.5	81.4	7,466.1	9.09	40,444.6	26.0	426,635.4	36.5
1980 476,250.0 35.8	3,272.1	38.1	25,281.6	54.0	6,236.4	77.8	7,356.0	47.1	42,146.1	53.3	434,103.9	34.7
1981 485,710.0 35.0	3,894.3	39.7	26,710.0	54.2	7,582.4	75.6	8,257.4	49.3	46,444.0	54.1	439,266.0	33.8
496,010.0	3,938.0	34.2	29,017.4	54.6	8,595.1	81.5	8,579.9	50.5	50,130.4	54.4	445,879.6	33.9
519,420.0	3,932.2	39.0	30,586.4	53.3	9,645.1	76.4	9,676.3		53,840.0	54.5	465,580.0	34.5
542,600.0	4,261.0	42.4	31,774.7	52.2	10,732.0	63.7	9,902.6		56,670.3	52.5	485,929.7	33.9
1985 578,850.0 35.3	4,390.4	40.9	35,119.6	50.4	11,645.3	29.0	10,367.3		61,522.6	50.9	517,327.4	34.1
. 620,440.0	4,716.0	44.5	37,748.9	49.7	12,199.6	62.4	11,770.7		66,435.2	51.8	554,004.8	36.8
1987 624,690.0 38.1	5,005.4	41.4	40,639.2	55.8	11,786.0	63.9	11,267.4		68,698.0	54.5	555,992.0	36.8
. 652,670.0	5,534.7	45.9	43,421.3	57.2	12,208.3	63.3	12,339.5		73,503.8	55.8	579,166.2	36.2
1989 686,010.0 36.6	6,254.1	37.7	46,078.2	56.5	11,959.0	63.6	12,793.0	48.0	77,084.3	53.7	608,925.7	35.2
1990 741,550.0 37.0	6,751.8	36.3	48,472.8	54.1	12,635.2	61.0	13,462.0	1.74	81,321.8	51.6	660,228.2	35.7
790,660.0	7,648.6	38.7	48,115.2	48.6	16,935.1	58.9	14,714.5	49.9	87,413.4	49.4	703,246.6	35.6
799,090.0	7,585.2	42.7	48,153.7	48.0	14,677.4	55.4	15,746.1	49.7	86,162.4	48.9	712,927.6	36.0
1993 746,310.0 37.2	Ϋ́	NA	45,918.9	46.4	11,288.3	52.4	16,032.3		Ϋ́	Ϋ́	ΑN	Ϋ́
1994 765,980.0 36.9	Ϋ́	NA	46,476.6	45.8	12,332.2	49.4	16,747.5		Ϋ́	ΑĀ	ΑN	Ϋ́
1995 789,452.0 36.9	A A	NA	NA	¥	NA	N A	AN		A A	N	AN	Ϋ́

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Airc	Aircraft	Communications	cations	Office & computers	mputers	Drugs & medicines	dicines	High-tech manufacturing	ınufacturing	Other manufacturing	facturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added V (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent)a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						Frai	France							
1970	215,840.0	38.5	3,042.1	35.8	6,646.6	52.6	4,787.8	61.4	2,449.5	30.8	16,925.9	45.9	198,914.1	38.0
1971	238,979.0	38.7	3,373.1	36.0	7,610.5	52.3	4,958.0	6.69	2,828.0	30.9	18,769.6	42.4	220,209.4	38.3
1972	265,734.0	38.8	3,861.5	36.8	8,710.6	20.7	5,288.2	59.3	2,995.6	30.6	20,855.9	45.0	244,878.1	38.4
1973	302,922.0	38.2	4,261.5	35.6	10,425.4	20.0	4,959.0		3,491.6		23,137.5	43.7	279,784.5	37.8
1974	342,318.0	34.5	4,491.6	31.2	12,618.0	49.6	5,255.1		4,085.3		26,450.0	45.4	315,868.0	33.9
1975	381,286.0	37.4	6,030.2	36.3	14,605.9	49.4	5,772.4	53.6	4,753.1	31.0	31,161.6	43.1	350,124.4	36.9
1976	440,749.0	37.0	9,302.5	38.6	16,866.2	48.3	7,429.9	54.1	5,197.5	31.1	38,796.2	43.4	401,952.9	36.4
1977	496,403.0	37.5	10,401.0	39.1	19,146.8	47.4	8,815.8	54.1	5,831.0	31.2	44,194.6	43.3	452,208.4	37.0
1978	564,275.0	39.1	12,980.0	45.8	21,402.6	46.7	8,825.8	53.3	7,558.0	33.3	50,766.4	44.8	513,508.6	38.6
1979	635,601.0	38.1	13,802.0	45.0	25,020.7	43.2	9,718.4	51.3	8,308.0	34.4	56,849.1	42.5	578,751.9	37.7
1980	679,520.0	35.6	16,032.0	39.5	27,054.3	43.9	11,041.2	51.1	9,857.0	34.4	63,984.5	42.0	615,535.5	35.0
1981	733,461.0	34.8	20,108.0	37.9	30,620.0	45.3	13,287.8	9.09	11,377.0	33.3	75,392.8	41.6	658,068.2	34.1
1982	821,520.0	35.0	22,480.0	37.0	34,829.1	45.0	15,791.5	48.4	12,526.0	32.3	85,626.6	40.8	735,893.4	34.4
1983	900,970.0	35.6	27,250.0	40.8	39,133.7	43.2	18,105.4		15,256.0	34.2	99,745.1	41.2	801,224.9	35.0
1984	956,273.0	34.6	29,913.0	36.9	46,728.4	42.9	25,249.8	48.3	15,271.0	31.2	117,162.2	40.2	839,110.8	33.9
1985	1,033,130.0	35.3	31,005.0	38.1	49,149.9	41.0	28,660.3	47.6	16,247.9	30.0	125,063.1	39.6	908,066.9	34.8
1986	1,120,100.0	38.4	31,444.0	38.6	50,915.5	40.3	29,114.3		18,851.0		130,324.8	39.8	989,775.2	38.2
1987	1,143,220.0	38.1	30,661.0	36.8	54,579.1	40.5	27,852.4	47.3	20,368.0		133,460.5	39.5	1,009,759.5	37.9
1988	1,242,130.0	38.3	35,566.0	37.3	59,239.2	40.9	31,247.6	45.8	21,645.9	31.5	147,698.7	39.2	1,094,431.3	38.2
1989	1,324,620.0	37.3	38,809.0	35.0	62,245.9	39.4	33,131.6	43.6	21,884.0	29.1	156,070.5	37.2	1,168,549.5	37.3
1990	1,394,500.0	37.7	39,840.0	32.5	64,615.6	38.9	34,470.6	1.44.1	24,548.9	30.5	163,475.1	36.5	1,231,024.9	37.9
1991	1,409,770.0	37.7	39,877.0	32.0	66,026.1	37.4	34,360.4	42.7	25,742.9	30.4	166,006.4	35.6	1,243,763.6	38.0
1992	1,402,730.0	37.6	39,883.0	31.4	66,815.0	37.7	32,387.0	41.8	29,427.9	31.9	168,512.9	35.5	1,234,217.1	37.9
1993	1,380,290.0	38.7	40,646.0	33.6	66,032.0	38.2	28,850.0	9.04	32,935.8		168,463.8	36.5	1,211,826.2	39.0
1994	1,423,060.0	37.9	38,330.0	31.4	67,573.0	37.4	28,584.0		31,715.8		166,202.8	35.0	1,256,857.2	38.3
1995	1,478,010.0	37.6	42,874.0	34.7	71,080.0	37.2	29,687.0	38.0	32,670.0	31.2	176,311.0	35.4	1,301,699.0	37.9

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

Value added (millions of nat'l currency) 14,839.0 16,093.0 18,088.0 20,969.0 22,720.0 27,657.0 31,883.0	(percent) ^a n (percent) ^a n 32.0 33.6 33.1 27.3 29.7 28.2 29.2 29.2 29.2 29.2 29.2 29.2 29.2	l I I	l ∂	Value added	Value added/	Value added (millions of	Value added/	Value aridad	Value added/	Value added	Manual Land		
	31.3 32.0 33.6 33.1 27.3 29.7 29.2 31.5	277 6	(bercent)a	(millions of nat'l currency)	production (percent) ^a	nat'l currency)	production (percent) ^a	~	production (percent) ^a	(millions of nat'l currency)	Value added/ production (percent) ^a	Value added V (millions of nat'l currency)	Value added/ production (percent) ^a
	31.3 32.0 33.6 33.1 27.3 28.2 29.2	474 E			United k	United Kingdom							
	32.0 33.6 33.1 27.3 29.7 28.2 29.2	4/4.0	78.5	546.5	36.9	117.6	32.3	226.3	3 42.5	1,365.1	45.7	13,473.9	30.4
	33.6 33.1 27.3 29.7 28.2 29.2	534.0	81.1	638.1	38.1	115.7	34.2	259.8	3 44.8	1,547.5	47.6	14,545.5	30.9
	33.1 27.3 29.7 28.2 29.2	577.7	82.6	717.2	39.1	161.9	38.9	259.8	3 44.0	1,716.6	48.5	16,371.4	32.6
	27.3 29.7 28.2 29.2 31.2	0.909	79.8	840.9	37.8	181.8	35.8	292.1	1 41.0	1,920.8	45.7	19,048.2	32.2
	29.7 28.2 29.2 31.2	563.5	64.0	919.4	35.4	216.3	33.3	316.3	3 35.6	2,015.6	40.2	20,704.4	26.5
	28.2 29.2 31.2	764.3	69.2	1,136.4	39.7	301.0	39.6	412.2	2 39.3	2,614.0	45.3	25,043.0	28.7
	29.2	842.4	38.5	1,223.2	35.4	271.1	30.9	474.0	9.78 0	2,810.7	36.1	29,072.3	27.6
1977 38,512.0	31.2	896.4	38.6	1,483.2	38.2	352.1	35.9	669.5	5 41.6	3,401.1	38.7	35,110.9	28.5
1978 44,586.0	!	1,046.4	39.8	1,805.7	40.4	433.7	38.4	808.6	3 43.2	4,094.3	40.6	40,491.7	30.5
197949,395.0	29.9	1,159.5	35.5	1,906.6	38.0	570.5	38.4	921.2	2 41.0	4,557.8	37.9	44,837.2	29.2
198054,144.0	30.7	1,727.3	37.1	2,407.2	40.4	642.0	40.5	1,107.7	7 45.4	5,884.2	40.2	48,259.8	29.8
	31.3	1,861.6	35.1	2,578.7	39.9	621.1	42.5	1,192.1	1 45.2	6,253.5	39.4	49,580.5	30.5
	32.3	2,004.2	37.7	3,051.5	42.5	771.6		1,493.2		7,320.4	42.4	53,837.6	31.3
	31.8	2,305.5	41.0	3,296.0	40.2	921.1	40.0	1,553.8	3 47.5	8,076.4	41.6	56,661.6	30.7
1984 68,634.0	30.3	2,139.2	36.8	3,890.0	38.6	1,111.6		1,725.8	3 47.0	8,866.6	38.8	59,767.4	29.4
1985 76,801.0	31.7	2,228.8	33.1	4,222.1	40.0	1,509.1		1,988.4	4 49.3	9,948.3	38.8	66,852.7	30.8
1986 82,422.0	34.1	2,942.0	36.2	4,285.4	39.7	1,499.9	36.5	2,182.4	4 49.3	10,909.7	39.7	71,512.3	33.4
1987 89,902.0	33.1	3,028.1	34.1	4,459.8	38.5	1,791.9	34.7	2,526.0	50.3	11,805.7	38.5	78,096.3	32.5
1988100,232.0	33.5	3,394.6	37.2	4,972.2	39.1	2,302.6	34.0	2,939.6	5 51.4	13,609.0	39.6	86,623.1	32.8
1989166.0	32.9	4,200.7	38.6	4,867.5	35.8	2,398.2	30.6	3,175.9	9 50.0	14,642.2	37.9	92,523.8	32.2
1990111,315.0	32.9	5,078.3	42.7	4,914.4	35.2	2,465.8		3,493.2	51.1	15,951.6	38.9	95,363.4	32.0
1991106,896.0	32.6	4,770.9	39.6	4,744.9	36.2	2,331.7		3,801.1		15,648.6	38.2	91,247.5	31.8
1992109,071.0	32.2	3,818.5	28.9	4,790.2	36.2	2,093.1		4,216.0		14,917.8	34.0	94,153.2	31.9
199313,940.0	32.7	NA	NA	Ϋ́	Α	AN A	¥	NA	۸	NA	Ϋ́Z	NA	Ϋ́
1994 121,272.0	32.4	NA	ΝΑ	Ϋ́	Ν	NA	¥	NA		NA	Ϋ́	NA	¥
1995 128,631.0	32.4	ΑN	NA	A A	Ϋ́	AN	Ν	NA	AN A	AN A	N	NA	NA

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Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Aircraft	raft	Communications	cations	Office & computers	mputers	Drugs & medicines	dicines	High-tech manufacturing	nufacturing	Other manufacturing	facturing
	Value added (millions of nat'l currency)	Value added/ production (percent)a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added Value added Value added Value added Value	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						Its	Italy							
1970	18,105,000.0	36.4	92,206.4	30.8	455,451.0	47.3	415,480.0	56.5	358,597.0	32.5	1,321,734.4	42.6	16,783,265.6	36.0
1971	19,452,000.0	36.4	110,424.0	30.4	518,762.0	48.5	369,564.0	29.7	386,415.0	32.8	1,385,165.0	45.9	18,066,835.0	36.0
1972	21,016,000.0	36.5	116,961.0	30.1	572,976.0	48.4	282,613.0	61.4	402,055.0	32.4	1,374,605.0	45.0	19,641,395.0	36.1
1973	26,064,000.0	36.6	115,832.0	28.2	660,403.0	20.7	227,590.0		420,390.0	34.9	1,424,215.0	43.7	24,639,785.0	36.2
1974	34,901,000.0	36.5	148,263.0	30.0	846,521.0	49.9	275,660.0		502,252.0	43.9	1,772,696.0	47.3	33,128,304.0	36.1
1975	38,436,000.0	36.6	205,515.0	27.1	920,971.0	46.5	312,219.0	64.4	606,728.0	41.4	2,045,433.0	43.6	36,390,567.0	36.2
1976	51,506,000.0	36.6	325,492.0	27.9	1,269,360.0	42.5	411,565.0	60.7	769,069.0	42.3	2,775,486.0	41.7	48,730,514.0	36.3
1977	61,862,000.0	36.6	407,608.0	29.5	1,583,880.0	39.6	488,671.0	58.2	839,007.0	41.3	3,319,166.0	40.2	58,542,834.0	36.4
1978	71,459,000.0	36.6	495,955.0	26.1	1,626,920.0	37.5	541,710.0	56.8	986,175.0	41.9	3,650,760.0	38.2	67,808,240.0	36.5
1979	87,935,000.0	36.6	626,340.0	27.5	1,916,120.0	37.8	772,625.0	58.3	1,191,210.0	42.2	4,506,295.0	39.2	83,428,705.0	36.5
1980	107,923,000.0	36.6	797,661.0	25.6	2,152,840.0	35.7	960,427.0	57.3	1,655,330.0	46.0	5,566,258.0	38.6	102,356,742.0	36.5
1981	124,119,000.0	36.0	1,191,630.0	25.7	2,617,300.0	37.7	1,174,270.0	55.1	1,825,950.0	44.8	6,809,150.0	38.3	117,309,850.0	35.9
1982	140,932,000.0	35.6	1,448,060.0	24.0	3,175,750.0	34.8	1,451,200.0	53.7	2,292,240.0	43.2	8,367,250.0	36.1	132,564,750.0	35.6
1983	156,417,000.0	35.6	1,574,680.0	31.2	4,114,330.0	51.9	1,685,190.0		3,600,430.0	61.4	10,974,630.0	51.0	145,442,370.0	34.8
1984	176,942,000.0	34.2	1,707,630.0	36.4	4,602,440.0	54.2	2,047,180.0	59.3	3,977,200.0	54.9	12,334,450.0	51.7	164,607,550.0	33.4
1985	196,484,000.0	34.2	1,864,080.0	26.8	4,901,630.0	41.9	2,732,170.0		4,745,400.0	50.2	14,243,280.0	42.0	182,240,720.0	33.5
1986	213,686,000.0	35.9	2,247,060.0	36.5	5,306,900.0	42.0	2,751,730.0		4,986,940.0	48.5	15,292,630.0	41.2	198,393,370.0	35.6
1987	230,093,000.0	35.8	2,321,930.0	40.3	5,816,800.0	46.4	2,914,680.0		5,598,060.0	43.0	16,651,470.0	41.1	213,441,530.0	35.4
1988	256,378,000.0	34.8	2,567,880.0	32.9	6,619,280.0	40.0	3,106,570.0		AN	N	N N	N	NA	¥
1989	279,654,000.0	33.8	3,273,600.0	45.2	7,884,310.0	49.3	3,308,120.0	31.2	ΨZ V	N	NA	Ν	NA	Ϋ́
1990	293,622,000.0	34.3	3,544,500.0	46.5	8,608,650.0	51.1	2,886,320.0	24.9	AN	Ν	Α̈́	A	AN	Ą
1991	300,246,000.0	34.9	3,285,340.0	42.9	8,860,790.0	52.5	2,904,940.0	30.3	NA	NA	N	NA	NA	¥
1992	307,906,000.0	35.5	A A	¥	8,883,320.0	54.2	3,167,660.0	32.5	NA	NA	NA	NA	NA	¥
1993	310,429,000.0	35.3	A A	¥	8,520,540.0	53.5	3,085,930.0	33.1	AN	N	NA	NA	NA	¥
1994	331,620,000.0	34.2	A A	N A	Ϋ́	Ą	AN	NA	NA	Ϋ́	Ϋ́	NA	NA	¥
1995	369,033,000.0	33.1	NA	NA	NA	NA	NA	NA	NA	NA	N	NA	NA	Ϋ́

Appendix table 6-4. High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95

	Total manufacturing	facturing	Airc	Aircraft	Communications	ications	Office & computers	mputers	Drugs & medicines	dicines	High-tech manufacturing	nufacturing	Other manufacturing	acturing
	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added Value in (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						South	South Korea							
1970	581,700.0	25.8	NA	Ą	16,885.7	40.7	312,745.0	36.2	11,706.0	39.2	341,336.7	36.5	240,363.3	18.2
1971	721,900.0	24.7	Ϋ́	N	25,898.1	39.5	327,933.0	38.1	16,206.0	40.6	370,037.1	38.3	351,862.9	18.0
1972	937,000.0	25.0	Ϋ́	N	39,020.8	33.7	365,772.0	39.5	17,120.5	36.4	421,913.3	38.8	515,086.7	19.4
1973	1,350,200.0	25.0	Ϋ́	NA	76,210.2	30.5	449,269.0	35.6	20,159.1	35.0	545,638.3	34.8	804,561.7	21.0
1974	1,970,300.0	23.2	Ϋ́	N	154,792.0	34.0	581,084.0	36.1	34,424.8	40.4	770,300.8	35.9	1,199,999.2	19.0
1975	2,665,300.0	24.1	Ϋ́	N	202,702.0	36.8	556,282.0	36.9	58,688.5	36.7	817,672.5	36.9	1,847,627.5	20.9
1976	3,862,400.0	25.3	Ϋ́	NA	307,050.0	32.8	600,145.0	39.2	84,443.9	43.2	991,638.9	37.2	2,870,761.1	22.7
1977	4,837,300.0	25.3	Ϋ́	NA	327,563.0	32.2	726,608.0	33.5	112,835.0	44.7	1,167,006.0	34.0	3,670,294.0	23.4
1978	6,513,900.0	25.3	Ϋ́	NA	436,609.0	28.4	836,794.0	33.5	148,212.0	45.2	1,421,615.0	32.6	5,092,285.0	23.9
1979	8,644,800.0	24.6	N	Ν	608,218.0	29.0	989,708.0	33.7	176,438.0	40.3	1,774,364.0	32.4	6,870,436.0	23.2
1980	10,743,100.0	22.8	NA	N A	700,517.0	29.7	1,179,570.0	33.5	266,539.0	43.4	2,146,626.0	33.0	8,596,474.0	21.2
1981	13,566,700.0	22.8	Ϋ́	NA	921,156.0	29.8	1,335,990.0	32.4	290,042.0	41.8	2,547,188.0	32.2	11,019,512.0	21.4
1982	15,376,400.0	23.2	Ϋ́	NA	974,522.0	29.8	1,542,630.0	34.0	380,122.0	44.7	2,897,274.0	33.5	12,479,126.0	21.7
1983	18,637,000.0	24.3	Ϋ́	Ν	1,358,180.0	30.2	1,986,090.0	34.3	456,738.0	46.9	3,801,008.0	33.7	14,835,992.0	22.6
1984	21,989,100.0	24.6	Ϋ́	Y Y	1,890,080.0	30.9	2,342,440.0	32.7	517,734.0	45.7	4,750,254.0	32.9	17,238,846.0	23.0
1985	24,080,000.0	24.8	Ϋ́	Y Y	1,958,250.0	30.9	2,853,440.0	35.6	558,327.0	45.0	5,370,017.0	34.4	18,709,983.0	23.0
1986	29,449,400.0	25.5	¥Z	NA	2,722,600.0	28.1	2,912,310.0	36.6	681,001.0	50.1	6,315,911.0	33.2	23,133,489.0	24.0
1987	35,173,500.0	25.1	Ϋ́	Y V	3,471,710.0	25.2	2,895,760.0	34.6	734,021.0	9.09	7,101,491.0	30.1	28,072,009.0	24.0
1988	42,679,200.0	26.3	Ϋ́	NA	4,395,730.0	26.1	3,117,800.0	34.6	989,079.0	46.5	8,502,609.0	30.4	34,176,591.0	25.4
1989	46,252,900.0	56.6	Ϋ́	N	4,896,630.0	28.8	3,535,620.0	34.9	931,269.0	49.9	9,363,519.0	32.3	36,889,381.0	25.5
1990	52,351,000.0	26.5	N	N A	5,855,520.0	30.8	3,946,330.0	35.0	923,660.0	38.7	10,725,510.0	32.8	41,625,490.0	25.3
1991	61,527,300.0	27.5	¥Z	NA	6,687,980.0	32.1	4,218,600.0	34.4	1,182,850.0	43.3	12,089,430.0	33.7	49,437,870.0	26.3
1992	66,711,400.0	27.7	Ϋ́	Y Y	6,947,920.0	32.4	4,007,420.0	33.7	1,357,870.0	43.7	12,313,210.0	33.8	54,398,190.0	56.6
1993	72,162,400.0	28.4	Ϋ́	Y Y	8,655,490.0	35.6	3,430,760.0	31.7	1,491,550.0	44.5	13,577,800.0	35.3	58,584,600.0	27.2
1994	82,131,900.0	29.1	Ϋ́	Y Y	10,401,400.0	36.0	3,189,820.0	34.2	1,669,010.0	47.2	15,260,230.0	36.5	AN A	¥
1995	94,484,800.0	Ϋ́	N A	Y Y	¥.	A V	ΑN	NA	¥ V V	Ϋ́	₹ Z	Ϋ́	Ϋ́	Ϋ́
0 9- 1														

High-technology manufacturing in selected industrialized countries, value added and domestic content: 1970-95 Appendix table 6-4.

Val				E 5 E			Ollice & collibratels	200						
	~	Value added/ production (percent) ^a n	Value added V (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added V (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a	Value added (millions of nat'l currency)	Value added/ production (percent) ^a
						Spain	ain							
	579,816.0	25.4	NA	NA	NA	NA	NA		11,914.3	28.4	NA	NA	NA	NA
	656,537.0	25.9	NA	Ν	∀ Z	¥	ΑN		11,983.0		NA	¥	AN A	Ν
19/2 2/81	810,781.0	26.8	NA	ΑĀ	Ϋ́	¥	ΑN	ΑN	16,409.0		N	¥	NA	Ϋ́
_	,005,790.0	27.4	NA	Ν	Ϋ́	¥	ΑN	A	21,130.4		NA	¥	AN A	NA
•	1,281,930.0	26.1	NA	Ν	∀ Z	¥	ΑN		25,830.8		NA	¥	AN A	Ν
_	,430,960.0	27.1	NA	Ν	Ϋ́	¥	ΑN		29,614.5		NA	¥	AN A	NA
	1,713,390.0	27.5	N A	Ν	¥ N	¥	ΑN		33,523.4	32.6	NA	¥	NA	Ϋ́
1977 2,148	2,148,850.0	28.6	NA	ΑĀ	∀ N	¥	ΑN	ΑN	43,109.3	36.8	N	¥	NA	Ϋ́
:	3,719,230.0	36.3	7,873.2	9.79	92,189.6	47.0	6,791.4	55.9	73,576.0	49.1	180,430.2	48.8	3,538,799.8	35.8
	4,229,370.0	36.8	10,448.9	6.97	94,687.3	48.4	8,194.6	53.0	87,042.0	51.9	200,372.8	51.1	4,028,997.2	36.3
19804,977	4,977,920.0	36.0	13,242.0	9.89	109,189.0	56.1	8,804.9	42.0	99,517.8	49.2	230,753.7	52.8	4,747,166.3	35.5
	5,321,120.0	35.8	18,693.7	8.59	113,029.0	56.9	14,861.5	43.8	121,279.0		267,863.2	54.5	5,053,256.8	35.1
	5,779,520.0	36.5	22,084.0	57.4	133,100.0	53.7	18,439.4	41.0	135,298.0		308,921.4	52.4	5,470,598.6	35.9
	6,541,970.0	36.4	25,394.5	64.2	155,770.0	25.0	20,476.0	48.9	147,872.0	53.1	349,512.5	54.3	6,192,457.5	35.7
1984 6,963	6,963,460.0	35.9	21,629.7	2.79	156,185.0	51.5	34,914.9	33.3	154,368.0		367,097.6	20.8	6,596,362.4	35.3
1985 7,53	7,531,800.0	36.2	26,964.2	70.2	154,470.0	50.2	42,962.5	30.1	187,252.0	55.6	411,648.7	49.8	7,120,151.3	35.7
	8,322,400.0	40.3	30,872.1	66.5	134,133.0	45.3	34,880.2	29.6	192,557.0		392,442.3	46.6	7,929,957.7	40.0
	9,029,700.0	40.7	35,729.1	60.2	144,252.0	44.3	31,444.4		217,789.0		429,214.5	46.7	8,600,485.5	40.5
	9,679,100.0	40.5	56,535.0	70.0	182,952.0	46.2	45,087.5		251,587.0		536,161.5	49.4	9,142,938.5	40.1
198910,675	10,675,100.0	40.3	58,861.1	61.6	221,873.0	44.3	55,574.4	42.4	320,233.0	54.5	656,541.5	20.0	10,018,558.5	39.8
19901,346	11,346,300.0	40.6	76,298.3	9.99	264,633.0	45.7	45,462.4	42.9	377,487.0	57.1	763,880.7	52.3	10,582,419.3	39.9
	12,011,700.0	40.9	61,303.8	63.9	240,803.0	46.0	64,162.5	41.0	453,695.0	57.5	819,964.3	52.4	11,191,735.7	40.3
199212,380	12,380,800.0	45.4	73,806.6	6.79	190,498.0	43.3	35,097.2	26.8	556,604.0		856,005.8	54.7	11,524,794.2	41.7
•	12,653,100.0	43.1	Y Y	NA	229,692.0	44.2	56,937.3	38.1	526,134.0		A A	Ą	NA	Α
_	3,993,500.0	44.0	N A	Ν	269,982.0	44.4	67,821.5	39.5	638,410.0	9.99	NA	¥	NA	ΑĀ
•	16,293,000.0	45.5	Ϋ́	Ν	∀ Z	Ϋ́	A A	N	A A	N A	NA	¥	Ϋ́	NA

NA = not available

NOTE: For U.S. value added, the Organisation for Economic Co-operation and Development reports data supplied by the U.S. Bureau of Economic Analysis on "Gross Product Originating."

"The production data used in this calculation are valued in national currency and are maintained by the Organisation for Economic Co-operation and Development in its Structural Analysis Database. These data do not match the production data provided in appendix table 6-5, which are valued in 1987 U.S. dollars.

SOURCE: Organisation for Economic Co-operation and Development, Structural Analysis Database (1996 edition).

See text table 6-2.

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Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						All n	All manufacturing industries	ing industr	ies							
Production All countries ^a	7,754.045	8.144.508	8.063.357	8.289.382	8.891.805	9.044.120	9.136.926	9.536.219	10,117,377	10,496,222	10.617.686 1	10.698.977	10.757.128	10.722.920	11,239,430	11.647.170
United States	2,070,477	2,201,960	2,077,227	2,143,027	2,326,374	2,282,612	2,300,127	2,465,600	2,568,882	2,553,131					2,859,185	2,949,769
Canada	173,666	188,763	173,291	183,293	208,511	222,268	230,649	237,541	247,747	243,392	229,974	217,454	223,449	242,460	256,594	267,526
Japan	1,387,623	1,486,046	1,550,489	1,594,840	1,713,927	1,791,557	1,734,699	1,747,725	1,898,321	2,034,442	2,188,385	2,316,907	2,226,411	2,082,610	2,108,386	2,149,120
Germany ^b	637,296			708,441	752,312	799,415	794,950	792,963	826,756	882,596	920,154	977,212	947,558	983,256	1,053,734	1,091,743
France	435,143			479,285	495,137	501,172	497,227	499,816	524,458	555,932	567,715	571,754	569,432	533,252	554,404	570,845
United Kingdom	348,576			358,294	389,559	402,759	400,410	422,852	438,471	448,461	445,029	410,934	435,123	432,630	454,420	472,542
Italy	303,334			319,591	347,187	342,220	338,427	345,702	366,457	376,611	366,952	361,669	355,602	347,457	355,722	367,267
China	262,631	243,072	CA	249,783	244,522	249,616	249,996	274,338	339,767	384,841	313,891	330,941	402,398	541,573	590,053	650,192
South Korea	56,177	66,004		79,768	92,905	96,487	116,248	138,475	153,162	160,954	177,614	191,979	203,919	220,871	240,551	264,786
Taiwan	71,000	74,776	75,383	83,700	97,038	104,372	128,187	139,648	152,272	152,585	149,580	159,417	158,268	167,748	173,906	186,186
Singapore	13,158	15,048	14,732	15,201	17,375	16,696	19,175	24,209	30,229	28,545	30,165	32,001	33,044	36,695	40,449	44,775
Hong Kong	19,404	23,400	21,411	27,058	27,864	24,962	31,356	36,428	37,173	34,477	32,188	30,364	28,728	28,230	28,229	29,812
Exports																
All countries ^a	1,442,807	1,583,926	1,571,788	1,591,194	1,741,579	1,828,029	1,901,237	2,005,552	2,310,416	2,482,678	2,566,262	2,738,487	2,927,673	3,118,098	3,409,123	3,714,972
United States	205,076	215,057	196,520	180,829	190,702	190,464	200,625	223,520	264,049	305,129	325,537	348,973	375,126	377,147	416,582	467,518
Canada	44,565	50,655		55,429	66,920	70,194	77,883	76,625	86,283	83,531	87,029	88,615	92,605	105,809	122,345	138,911
Japan	167,319	193,214		200,055	228,986	240,658	239,059	236,189	256,177	271,250	282,871	286,565	289,159	278,073	278,147	294,184
Germany ^b	201,714	236,978		242,019	263,450	285,055	279,874	283,854	322,975	344,675	338,540	354,008	357,603	351,484	386,804	412,372
France	102,074	115,528		114,475	123,326	127,871	125,219	129,568	149,018	159,338	163,496	176,072	184,356	191,650	203,617	217,441
United Kingdom	97,352	92,825		91,172	98,780	105,171	116,086	121,666	144,213	146,143	153,904	167,575	168,925	174,021	179,349	195,422
Italy	82,515	94,925	95,392	96,995	103,152	112,328	111,828	112,926	127,040	136,181	133,165	136,445	141,531	164,161	176,868	191,834
China	14,390	16,860	16,614	16,623	18,414	15,966	20,939	25,122	38,878	38,979	54,583	63,869	77,492	87,194	107,234	119,935
South Korea	17,633	23,296		27,608	33,474	34,534	39,268	48,513	59,811	62,943	60,612	66,898	69,541	75,207	83,946	93,778
Taiwan	20,286	22,452		23,829	28,506	29,328	41,132	56,755	67,491	75,355	76,088	84,905	96,163	100,720	107,293	117,964
Singapore	11,180	12,492		14,857	17,006	16,498	21,250	25,985	36,375	42,896	45,966	52,626	58,917	69,654	84,947	96,015
Hong Kong	19,453	23,207	23,216	25,108	30,337	31,591	36,790	47,886	62,022	68,659	74,901	86,608	103,239	115,988	124,885	135,950
Imports																
All countries ^a	1,355,470	1,465,746	1,457,058	1,499,989	1,656,996	1,736,679	1,822,093	1,931,793	2,235,044	2,404,720	2,495,021	2,648,558	2,828,165	2,992,882	3,291,253	3,585,730
United States	173,649	204,481	210,587	250,310	324,929	353,212	366,596	365,466	384,887	406,655	396,489	387,994	435,854	489,119	537,703	576,158
Canada	51,245	58,682		57,261	68,601	71,350	72,911	78,075	90,093	98,754	99,412	100,695	101,563	108,776	123,213	133,322
Japan	47,230	50,930		52,093	58,471	59,425	70,600	87,645	113,298	127,516	134,680	139,263	140,617	152,266	174,714	197,470
Germany ^b	135,526	133,822	130,627	139,156	144,468	153,151	173,739	185,893	206,584	219,452	250,145	289,071	297,136	290,477	313,343	342,921
France	98,668	104,291	109,703	104,221	107,032	113,643	124,751	135,868	160,660	173,266	180,163	186,363	188,200	186,337	201,498	216,062
United Kingdom	96,239	69,963	101,659	108,492	116,296	121,566	123,549	133,840	168,970	172,383	169,094	163,460	170,521	180,254	191,518	202,162
Italy	66,758	65,862	65,581	64,155	71,448	77,953	83,583	95,307	109,066	118,417	123,532	128,218	132,604	118,890	128,266	139,186
China	14,289	14,604		16,984	27,482	44,783	40,395	38,940	52,564	53,141	51,077	62,607	80,836	115,361	124,715	137,863
South Korea	13,022	14,866		17,648	21,232	21,472	24,892	30,324	36,218	41,572	45,731	52,718	49,631	52,659	64,567	76,666
Taiwan	13,436	14,463		14,835	17,295	16,200	19,659	26,525	34,951	39,898	40,662	46,822	54,346	56,858	60,356	66,577
Singapore	17,715	19,565	21,087	21,974	22,851	21,341	22,172	26,592	33,912	39,341	45,575	51,359	56,768	66,698	1,497	86,354
Hong Kong	22,741	25,879		26,029	30,677	29,929	32,900	40,676	56,456	56,355	69,827	83,032	99,873	96,913	111,483	122,135

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Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Apparent consumption All countries* United States Japan Germany* France United Kingdom	8,147,070 2,105,792 191,269 1,316,536 662,759 460,046	8,555,504 2,261,665 209,252 1,400,492 688,175 482,285 374,487	8,477,702 2,155,857 1,84,596 1,464,516 690,524 506,017 381,367	8,736,480 2,272,144 198,864 1,505,936 715,405 500,939 402,928	9,393,800 2,523,681 226,800 1,611,164 752,801 513,261 436,728	9,572,261 2,508,602 240,892 1,681,672 796,702 522,694 450,408		10,146,039 2,682,354 2,58,238 1,669,374 823,871 542,524 471,733	10,833,030 2,778,412 273,305 1,831,589 857,135 578,030 506,780	11,273,876 2,757,552 279,780 1,971,387 914,116 614,728 519,154				,	12,288,728 3,123,907 2,89,283 2,087,976 1,155,929 609,991 520,766	12,804,129 3,220,240 300,078 2,182,756 1,205,635 629,634 538,791
Italy	318,982 265,251 56,204 70,785 21,531 27,721	320,178 244,231 63,763 74,193 24,180 32,092	311,857 237,968 66,428 74,079 24,819 29,514	323,864 254,165 77,074 82,941 24,778 34,537	355,092 257,759 89,479 95,695 26,042 36,153	350,927 281,979 92,618 101,771 24,286 31,610	352,902 371,126 274,544 294,317 112,778 133,738 121,311 129,701 23,645 29,161 37,154 41,834 High-tech industries®	371,126 294,317 133,738 129,701 29,161 41,834	396,969 364,063 146,083 144,767 33,854 48,264	410,847 409,692 156,805 145,201 32,175 42,738	408,079 325,969 179,355 142,585 37,478 47,983	405,491 348,929 193,297 153,140 39,562 51,656	400,675 430,243 199,274 153,145 40,786 54,002	364,914 597,814 214,988 162,367 45,422 48,229	373,110 637,164 239,496 167,531 47,273 53,933	385,967 691,281 264,353 178,265 51,594 56,504
All countriess" United States Japan Germanyb France United Kingdom Italy United States South Korea South Korea Hong Kong All countriess United States Japan Japan Germanyb Gernada Japan Japan Gernady Japan Japan Gernanyb France Japan Japan South Korea Taiwan Gernanyb France Japan Japan South Korea Taiwan South Korea	591,039 216,290 7,759 140,544 47,362 26,839 31,393 11,609 4,107 5,423 22,2616 22,258 14,373 7,099 14,143 4,355 2,707 2,502 2,502 2,707 2,502 2,707 2,502 2,502	231,553 8,545 162,815 52,883 31,102 31,244 15,684 10,146 4,958 5,889 2,889 3,138 158,619 3,138 3,138 3,138 1,561 158,619 3,009 27,405 20,405 13,651 13,651 20,405 27,405 2	678,200 248,692 8,077 175,356 56,008 33,899 32,572 14,633 10,072 5,155 6,020 2,748 2,949 164,430 36,074 3,816 28,588 23,638 23,638 22,639 2,727 2,727 2,727 2,727 2,727	29,533 264,003 8,048 191,578 62,082 32,944 35,228 15,822 12,781 6,813 7,626 3,762 3,670 181,571 40,678 3,928 35,077 22,191 10,728 16,072 5,799 417 3,073 3,449	204,695 9,787 204,695 9,798 226,617 68,079 37,722 40,488 16,217 15,344 9,253 9,921 5,354 3,927 215,190 4,943 4,943 4,943 4,507 113,407 12,907 12,907 12,907 13,443 4,443 4,443 4,443 4,714	874,602 311,135 11,080 235,344 66,461 37,474 43,895 14,600 24,632 9,399 10,437 5,432 2,833 2,833 47,384 47,384 13,207 20,862 8,141 4,486 3,882 4,446 3,882 4,446 4,417	907,164 320,961 11,922 234,575 65,832 37,132 45,816 15,406 23,939 13,326 15,697 7,437 3,856 5,1599 50,338 23,678 12,829 50,338 23,747 7,639 7,639 7,639 7,639 6,169 6,169	933,213 301,400 13,489 247,089 64,024 39,629 49,984 16,510 28,567 17,568 10,959 5,127 52,426 52,442 6,274 52,442 14,719 27,173 10,035 9,445 10,035 9,146	1,041,079 325,241 15,031 283,274 67,679 44,027 54,628 19,050 38,912 21,245 21,245 21,245 5,724 71,978 6,788 62,270 29,445 17,657 26,665 9,453 12,967 11,468 11,468 11,468 11,465 11,465 11,468	327,793 327,793 311,087 75,599 48,399 58,255 20,593 43,833 21,526 22,797 11,843 5,019 80,340 7,276 67,584 33,684 20,586 22,686 22,686 22,686 21,38 11,483 31,644 11,483 21,584 31,644 11,483 21,584 11,483 21,584 11,483 21,584 11,483 21,584 11,483 21,584 11,483 21,584 21	1,146,496 338,027 16,260 335,719 80,798 50,140 59,284 20,766 4,771 23,497 12,946 4,761 4,761 8,566 71,106 30,447 8,566 71,106 10,689 4,139 11,016 10,689 11,016 11,016	341,448 341,448 361,526 89,459 54,040 56,133 19,289 35,939 35,939 35,939 10,005 7,933 10,005 7,494 37,419 10,741 4,780 10,741 4,780 10,741 4,780 10,741 4,780 10,741 10,74	1,200,246 363,270 18,352 32,368 85,107 52,605 57,843 18,346 47,162 25,946 25,946 25,946 47,162 25,946 47,05 10,687 10,687 10,687 36,414 26,790 11,375 11,375 1	350,016 350,016 17,746 307,732 92,529 51,125 56,105 65,115 65,115 77,567 4,076 4,076 10,409 72,528 37,051 28,196 12,792 7,629 18,922 28,196 39,926 12,792 7,629 18,922 28,196 33,388 20,667	1,305,495 397,297 20,317 320,924 101,167 53,478 62,200 17,673 71,375 29,779 20,459 4,236 42,519 30,200 42,834 13,397 10,458 22,833 29,820 45,047 22,893 22,893 22,893 22,893 22,893 22,893 22,893 22,893	1,401,256 444,713 21,776 320,202 106,078 56,041 66,811 18,806 81,341 39,632 33,325 23,410 4,688 128,709 14,890 79,652 46,100 32,907 48,257 12,173 27,707 34,606 51,963 27,707

Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Imports																
All countries ^a	121,045	143,141	147,261	165,042	199,632	212,984	230,269	256,721	319,690	361,256	389,724	431,156	466,251	499,417	575,783	645,356
United States	16,953	22,576	24,361	33,224	47,650	50,088	52,738	55,719	64,431	73,906	73,855	78,537	93,060	102,881	116,797	134,379
Canada	5,080	6,207	5,632	6,577	8,493	8,319	9,038	10,222	13,424	13,412	14,828	16,889	17,784	17,539	20,050	23,422
Japan	4,726	5,561	5,332	6,293	999'9	7,491	8,854	10,333	13,279	15,595	18,425	19,171	20,650	23,595	29,425	34,607
Germany ^b	11,513	13,716	13,939	15,326	16,573	18,385	21,101	23,721	27,498	31,511	38,628	42,703	43,018	42,171	47,692	53,577
France	8,254	11,672	13,924	12,206	13,925	14,222	14,319	16,184	22,725	25,967	26,873	32,247	29,542	29,074	31,681	34,978
United Kingdom	10,758	11,441	11,922	14,014	15,892	17,097	17,117	19,775	25,832	29,351	30,230	29,489	30,848	34,268	36,872	38,520
Italy	5,378	6,070	6,150	6,167	7,665	8,752	9,594	11,323	14,115	14,814	16,652	17,785	17,489	15,596	17,024	18,575
China	851	948	784	1,288	3,129	6,104	3,943	4,832	6,321	6,246	6,176	7,866	11,375	16,050	19,394	21,000
South Korea	1,737	1,933	2,041	2,924	3,718	3,558	4,337	5,303	7,577	8,102	8,652	10,142	10,357	10,858	12,987	15,611
Taiwan	1,791	2,080	2,310	2,507	3,135	2,947	3,925	5,403	7,048	8,411	9,078	10,845	12,892	13,932	15,170	16,916
Singapore	2,977	2,974	3,274	4,494	5,121	5,127	5,461	7,120	9,638	11,980	14,448	16,711	18,864	23,358	30,015	34,259
Hong Kong	2,658	2,850	2,785	3,457	4,924	4,457	4,809	6,487	9,891	9,998	12,743	15,512	19,500	19,444	23,111	26,298
Apparent consumption																
All countries ^a	619,157	677,833	714,695	772,608	897,756	933,984	971,482	1,005,470	1,134,762	1,214,277	1,262,325	1,318,735	1,340,470	1,346,029	1,481,316	1,605,229
United States	209,338	227,781	248,830	269,964	322,943	329,573	339,302	317,448	341,871	348,450	352,266	355,396	387,151	385,506	439,082	494,936
Canada	10,807	12,137	10,826	11,664	14,557	15,360	16,517	19,013	23,404	23,786	24,687	26,601	28,179	27,542	31,145	33,801
Japan	129,530	148,735	160,516	173,148	200,698	209,092	208,036	220,705	252,792	279,200	304,202	328,645	300,448	280,427	298,039	315,218
Germany ^b	50,890	55,443	57,412	65,193	70,756	70,210	73,702	74,125	78,818	88,512	101,405	111,403	107,906	114,507	125,682	133,236
France	29,931	36,187	39,333	37,370	42,295	42,134	42,170	45,175	54,000	59,513	62,380	68,015	63,125	59,915	63,439	66,944
United Kingdom	31,537	32,453	33,186	37,234	42,571	45,428	45,225	53,658	60,166	65,691	66,050	56,351	60,851	59,867	66,685	69,149
Italy	18,452	17,983	17,088	18,247	19,510	18,132	20,084	22,923	27,076	28,656	30,528	30,149	28,487	24,265	26,145	27,616
China	12,179	10,786	10,542	13,696	17,840	30,311	27,205	32,494	43,342	48,300	35,469	39,911	53,173	75,306	82,854	88,637
South Korea	4,409	5,146	5,423	7,353	9,646	9,670	12,821	15,931	19,389	19,016	22,251	22,822	23,375	26,961	31,022	35,016
Taiwan	4,789	5,291	5,803	7,249	809'6	10,298	15,192	18,115	20,587	21,915	23,192	25,644	26,323	31,403	29,315	32,163
Singapore	3,373	3,691	3,839	5,443	6,778	6,617	7,403	10,044	12,189	9,222	10,607	11,063	10,720	12,563	12,429	13,526
Hong Kong	2,933	3,585	3,514	4,290	4,920	3,586	4,659	6,081	7,299	2,800	7,028	7,854	9,979	7,178	7,882	8,629
							Aircraft	aft								

Production																
All countries ^a	111,561	118,741	121,166	122,112	132,880	143,729	153,164	159,360	170,150	178,634	179,623	181,645	181,957	166,030	181,099	179,616
United States	70,590	74,755	76,806	78,648	85,599	92,782	101,477	103,600	108,325	108,401	113,407	114,356	110,582	92,320	104,937	99,486
Canada	2,226	2,394	1,835	1,613	2,037	2,377	2,813	3,021	3,534	3,915	4,219	3,820	3,509	3,121	4,181	4,245
Japan	2,999	3,463	3,588	3,687	3,977	4,426	4,232	5,026	5,560	5,518	5,464	5,356	5,655	5,461	5,152	5,048
Germany ^b	4,276	4,817	4,734	4,647	4,704	5,473	5,253	6,104	6,318	8,484	8,951	8,946	7,566	7,638	7,430	7,805
France	7,267	9,162	10,410	9,098	10,665	9,243	7,953	8,318	9,814	11,101	10,378	12,122	10,371	9,062	8,614	8,648
United Kingdom	10,519	10,511	10,119	10,309	10,387	11,730	13,478	14,341	14,737	16,242	16,543	15,614	16,318	15,082	15,417	15,955
Italy	3,236	3,138	3,123	2,877	2,934	2,991	3,207	3,205	3,977	4,112	3,423	3,112	2,864	2,552	2,615	2,653
China	3,875	2,982	2,989	3,792	3,808	609'5	5,169	980'9	6,403	7,951	4,783	5,549	11,238	17,489	19,019	21,125
South Korea	-	2	2	7	က	က	က	4	2	2	7	400	290	256	277	317
Taiwan	188	197	194	171	182	208	270	267	259	300	291	335	309	351	329	369
Singapore	92	100	131	173	201	282	306	324	372	297	334	337	454	463	485	539
Hong Kong	0	0	0	-	-	-	-	-	2	2	2	137	157	144	137	149

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Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

24 1.08 1.777 2.28 1.700			38,138 39,462 14,001 12,239 1,062 1,080 210 6,945 7,725 3,083 8,488 8,203 8,488 1,322 1,546 5 47 95 165 199 166 41 29 29,274 30,961 3,688 4,935 1,779 1,265 1,803 1,366 3,110 2,728 4,474 5,138	39,462 12,239 1,080 1,080 7,725 4,228 8,488 1,546 47 165 29 30,961 4,935 1,265 1,366 2,728 5,138 3,266
1,908 1,5281 2,629 11,331 1,194 3,42 3,42 3,42 1,194 1,1	0004009V 88 E0000		1,062 1,080 210 6,945 3,083 4,228 8,203 8,488 1,322 1,546 5 95 165 0 1 1 199 166 41 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266 5,100 1,000	1,062 1,080 210 6,945 3,083 8,228 8,203 8,428 8,203 8,428 1,322 1,546 5 0 1 1 199 166 41 29 29,274 30,961 3,688 4,935 1,1779 1,265 1,803 1,106 3,110 2,728 4,474 5,138 2,927 3,266
3,281 2,629 11,331 1,194 35 342 34,717 6,847 1,713 2,179 3,035 9,095	849027 88 19008		6,945 7,725 3,083 8,488 1,322 1,546 95 165 0 1 199 166 41 29 1,729 1,265 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 4,925 1,265 1,205	6,945 7,725 3,083 4,228 8,203 8,488 1,322 1,546 95 165 0 1 199 166 41 29 29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
2.629 11,194 1,194 35 34,717 6,847 1,713 2,179 3,035 9,095	4490007 88 E E E E E E E E E E E E E E E E E E		3,083 4,228 8,203 8,488 1,322 1,546 95 165 0 1 199 166 41 29 29,274 30,961 3,688 4,935 1,179 1,265 1,1803 1,366 3,110 2,728 4,474 5,138 2,927 3,266	3,083 4,228 8,203 8,488 1,322 1,546 5 47 95 165 0 1 199 166 41 29 41 29 29,274 30,961 3,688 4,935 1,779 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
34.5 1,194 1,195 34.5 1,195 1,195 1,717 1,713 1,035 3,035 3,035	38 38 38 38 38 38 38 38 38 38 38 38 38 3		29,274 30,961 1,366 3,110 2,728 4,474 5,138 2,927 3,266 4,474 5,138 2,927 3,266 4,627 4,62	29,274 30,961 3,688 4,935 1,1779 1,265 1,306 3,110 2,728 4,4774 5,138 2,927
35 342 1 138 58 58 7477 1,713 1,713 2,179 3,231 3,035 9,995	272 238 3383 3461 3,655 3,559 3,956		5 47 95 165 0 1 199 166 41 29 29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266	5 47 95 165 0 1 199 166 41 29 29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
342 138 138 58 1,717 1,713 2,179 3,035 9,095	272 38 33 33,61 1,60 1,95 1,95		29, 274 30,961 29 1,865 3,110 2,728 4,474 5,138 2,027 4,265 1,265 3,100 2,728 4,474 5,138 2,027 4,000 1,000	29,5 165 0 1 199 166 41 29 29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
138 58 58,717 6,847 1,713 2,179 3,035 9,995	38 33,61 1,60 1,95 1,95		29,274 30,961 29 1,179 1,265 1,180 2,728 4,935 1,180 2,728 4,474 5,138 2,927 3,266 2,505 1	29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
138 58 34,717 1,713 2,179 3,035 9,095	38 3 3,61 3,61 1,60 1,95		29,274 30,961 29 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266 4,927 3,266	29,274 30,961 3,688 4,935 1,1779 1,265 1,303 1,100 2,728 4,4774 5,138 2,927 3,266
34,717 6,847 1,713 1,713 2,179 3,231 3,035 9,999	19,53,00,00,00,00,00,00,00,00,00,00,00,00,00		29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266	29,274 30,961 (3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
34,717 6,847 1,713 2,179 3,035 999	65 53 56 56 56 58		29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266	29,274 30,961 3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
6,847 1,713 2,179 3,231 3,035 992	50 50 8		3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266	3,688 4,935 1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
1,713 2,179 3,231 3,035 999	9, 8, 4		1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266	1,179 1,265 1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
2,179 3,231 3,035 2,992	38 8		1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266	1,803 1,366 3,110 2,728 4,474 5,138 2,927 3,266
3,231 3,035 2,992	å		3,110 2,728 4,474 5,138 2,927 3,266	3,110 2,728 4,474 5,138 2,927 3,266
3,035	3		4,474 5,138 2,927 3,266	4,474 5,138 2,927 3,266
2 992	55,		2,927 3,266	2,927 3,266
1001	9		100	
1,100	5,		1,085	1,085 1,279
929	8		302 155	302 155
545	8		344 694	344 694
225	45		394 340	394 340
618	97		786 859	829
554	24		217 239	217 239
0	3			
159,553			126,323 138,069	126,323 138,069
51 96,963 96,119	9,7	82,343 88	72,952 82,343	82,343
3,092	2,90		1,991 2,400	1,991 2,400
6,295	, k		5,342 5,209	5,342 5,209
6,802	9		4,251 3,542	4,251 3,542
9,079	ಟ್ಟ		11,328 12,732	11,328 12,732
8,159	9,		7,175 7,335	7,335
3,551	8,		3,123 3,233	3,123 3,233
5,814	4		4,089 3,921	4,089 3,921
492	47		281 542	281 542
494	63		565 521	521
808	8		793 922	793 922
512	220		188 218	188 218

Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						Office a	nd comput	and computing machinery	nery							
Production All countries ^a	89,805	99,954	110,386	124,913	155,235	161,471	160,899	174,946	200,527	217,434	229,330	234,965	238,019	243,951	260,766	285,557
United States	935	38,280 1,200	1.257	1.286	1.721	1,958	1.869	00°,10 1.998	2,550	2,563	2,629	26,553	2.945	3.100	3.721	92,324 4.325
Japan	30,007	33,944	37,221	39,512	45,612	51,284	52,582	59,340	67,734	78,999	89,183	96,140	91,153	85,975	80,573	81,311
Germany ^b	6,015	7,074	8,099	10,116	13,028	11,721	10,286	9,318	9,951	10,280	10,748	14,799	13,036	15,368	17,346	18,295
France	4,668	5,068	5,043	5,923	6,862	7,211	7,519	8,190	8,353	8,821	8,608	9,365	9,776	10,119	10,670	11,408
United Kingdom	2,729	2,579	3,011	3,949	5,644	7,282	6,833	8,476	10,870	12,204	12,626	12,107	12,514	12,807	14,767	16,382
China	2,570 401	2,092	2,330	3,578 438	4,101 539	2,782 508	2,733 554	616	5,263 758	5,795 742	0,04 563	5,004 625	4,700 803	1,071	1 274	2,309
South Korea	49	62	23	176	367	489	823	839	1.189	1.261	1.368	1,444	1.449	2.826	4.024	4.712
Taiwan	222	267	296	505	883	1,011	2,063	3,046	3,374	3,558	3,870	4,167	4,304	4,885	4,956	5,695
Singapore	73	83	151	398	669	306	1,464	2,284	3,759	4,746	5,603	5,741	6,497	9,259	11,304	13,075
	171	2	2	5	200	000	5	-	066	617,1	4,00,1	2,103	006,1	, ·	2	0,000
Exports	0	00	0	6	, , , , , , , , , , , , , , , , , , ,	0	9		0	0	000	100	1	1	000	2
All countries	23,833	29,734 10,596	33,229	42,445	56,513 16.140	17 007	18 022	85,254 21,328	106,119 26.146	119,139	208,121	30,605	32,720	32,511	36,232	43.865
Canada	736	903	983	1.142	1,453	1,504	1,582	2.060	2,623	2,448	2,748	3,206	3,695	3.841	5,116	6.381
Japan	2,773	3,282	4,354	7,059	10,414	11,245	13,820	16,106	20,042	21,789	23,594	24,039	25,968	26,048	25,839	26,940
Germany ^b	2,943	3,689	4,026	4,779	2,669	7,280	7,338	7,219	7,726	8,614	8,490	9,076	8,435	8,846	10,007	10,714
France	1,607	2,022	2,021	2,567	3,154	3,543	3,954	4,610	4,862	5,293	5,040	5,693	6,039	6,180	6,778	7,503
United Kingdom	2,140	2,120	2,518	3,127	4,603	2,600	5,625	898'9	8,756	10,040	10,057	10,453	10,360	12,250	13,748	15,929
Italy	1,696	1,372	1,582	1,705	2,016	3,017	2,852	2,792	3,552	4,244	3,838	3,856	3,658	4,631	4,707	5,245
China	7	4	2	12	19	=	47	84	224	194	399	543	1,149	1,659	2,436	3,160
South Korea	77	91	127	249	481	655	1,094	1,636	2,590	2,918	2,690	2,889	3,029	3,471	3,448	4,458
Taiwan	191	246	283	478	927	1,181	2,164	4,083	5,897	7,550	9,156	11,176	14,008	15,033	16,969	19,638
Singapore	111	125	229	602	1,059	1,278	2,216	3,457	5,690	7,185	9,097	10,183	13,102	16,979	21,717	25,783
Hong Kong	403	080	070	706	1 / 2, 1	1,347	1,300	1,738	2,539	2,790	3,234	3,950	4,975	5,3/8	6,152	0,093
Imports	000	9	0	1	1	00	7,	0.00	707	1	0	7	7	0	7	000
United States	23,200	3,142	32,600 4 703	7 844	11 778	13.023	15.279	18,664	23 229	26,711	28 141	30.472	36.274	42 103	47 755	55.622
Canada	1,437	1,912	2,029	2,315	3,342	3,285	3,333	4,162	4,754	5,080	5,814	6,633	7,236	7,548	8,426	9,620
Japan	1,023	1,142	1,227	1,333	1,604	1,938	2,227	2,679	3,661	4,510	5,102	5,598	5,950	7,073	9,028	10,763
Germany ^b	3,128	3,385	3,502	4,415	5,391	6,565	7,553	906'8	10,332	12,182	14,034	15,878	16,570	16,469	18,200	20,821
France	2,526	2,801	3,246	3,798	4,364	5,017	5,820	6,479	7,946	8,253	8,299	8,229	8,789	9,208	10,851	12,422
United Kingdom	2,906	3,283	3,807	4,877	6,158	6,548	6,864	8,588	10,928	12,486	12,637	12,666	13,547	15,363	15,866	16,884
Italy	1,478	1,650	1,605	1,769	2,495	3,054	3,328	4,131	4,963	4,829	5,085	5,428	5,552	5,152	5,215	5,533
South Korea	120	130	99 890	410	8/5 422	1,055	ZC/	1,031	1.340	1 498	1 723	1,218	1,709	2,359	2,855	2,311
Taiwan	143	187	230	299	411	456	689	945	1.384	1,598	1,774	1.974	2,270	2.266	2.608	3.014
Singapore	207	262	393	644	814	923	1,063	1,663	2,542	2,990	4,118	4,564	5,413	6,873	8,447	10,275
Hong Kong	463	439	437	634	1,021	927	780	1,081	1,657	1,654	2,030	2,507	3,655	3,480	4,342	4,988

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Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

## 97.81 109.200 120.964 138.828 173.861 185.042 184.920 204.226 277.867 74.976 284.77	1,00, 20, 30, 30, 30, 30, 30, 30, 30, 30, 30, 3	Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
9, 1872 108, 202 20 20, 202, 208 20 63, 215 20 20 20 20 20 20 20 20 20 20 20 20 20	1,800 2,473 2,444 18,826 4,1246 18,124 14,124 1,2426 2,375 2,537 2,548 2,741 2,548 2,741 2,548 2,741 2,548 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,741 2,749 2,749 2,741 2,749 2,749 2,741 2,749 2,749 2,749 2,749 2,741 2,749	Apparent consumption						9			1					1		
1,000	1,000 2,473 4,074 4,074 4,074 4,074 4,024 7,02	All countries ^a	97,812	109,320	120,984	138,826	173,861	183,042	184,920	204,326	237,267	259,147	274,307	284,787	293,639	305,913	332,492	368,438
2008 22,777 26,787 26,	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	Capada	30,009	04,780 0 787 0 788	000,040	540,04	3 950	03,131	1, -	477,00	74,241	7,900	6 382	00,040	00,792 7.410	03,240	102,472 8.463	0 303
1,224 1,127 1,12	1,224 8187 8196 1154 14879 13909 1344 15894 1751 1913 25 046 24,376 24,376 2527 24,278 24,289 25,244 24,279 2	Janan	20,000	32,767	35.375	35.870	888.08.	4,110	45,002	4,024	57.311	3,022 68,201	77 719	0,070	78.868	74.767	71 474	2,203
6,007 6,002	6 6 7 6 7 6 7 6 7 7 7 8 7 8 8 9 9 4 9 6 7 10 4 2 11340 1274 13 4 3 13 4 3 14 1 1 1 1 1 1 1 1 1 1 1	Germanv	7,324	8.187	960'6	11,554	14.879	13.909	13,445	13,898	15,594	17.251	19,613	25.046	24.316	27.008	30,083	32.124
3822 4007 41734 6.305 6.1140 1.586 1.640 1.7724 16.400 1.7724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40 17.724 16.40	3227 3466 3153 4256 5184 9425 9206 11440 14581 16686 15686 15686 17822 16440 17724 1722	France	6,027	6,402	6,825	7,862	8,944	9,667	10,482	11,340	12,790	13,256	13,274	13,493	14,218	14,882	16,649	18,129
290 87 346 3153 429 527 3827 4296 527 177 1222 1140 1578 1579 7390 868 777 1240 1578 1579 7390 868 777 1240 1578 1578 1579 7390 868 777 1222 1140 1578 1578 1579 7390 868 777 1222 1140 1578 1578 1579 7390 868 777 1222 1140 1578 1578 1579 1579 7390 868 777 1222 1140 1578 1578 1579 1579 1579 1579 1579 1579 1579 1579	297 3.466 3.153 4.259 5.371 3.921 4.266 5.209 7.370 7.803 86.88 7.792 7.	United Kingdom	3,923	4,097	4,734	6,305	8,184	9,425	9,206	11,640	14,831	16,685	17,212	16,480	17,724	18,400	19,901	21,057
223 472 529 642 775 1,261 1,661 1,558 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,561 1,562 1,461 1,562 1,461 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,762 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,462 1,562 1,462 1,562 1,462 1,562 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 1,462 <td>220 472 282 464 1,584 1,281 1,615 1,584 1,686 1,785<!--</td--><td>Italy</td><td>2,971</td><td>3,466</td><td>3,153</td><td>4,259</td><td>5,371</td><td>3,921</td><td>4,266</td><td>5,209</td><td>7,970</td><td>7,930</td><td>8,688</td><td>7,982</td><td>7,923</td><td>7,019</td><td>7,116</td><td>7,569</td></td>	220 472 282 464 1,584 1,281 1,615 1,584 1,686 1,785 </td <td>Italy</td> <td>2,971</td> <td>3,466</td> <td>3,153</td> <td>4,259</td> <td>5,371</td> <td>3,921</td> <td>4,266</td> <td>5,209</td> <td>7,970</td> <td>7,930</td> <td>8,688</td> <td>7,982</td> <td>7,923</td> <td>7,019</td> <td>7,116</td> <td>7,569</td>	Italy	2,971	3,466	3,153	4,259	5,371	3,921	4,266	5,209	7,970	7,930	8,688	7,982	7,923	7,019	7,116	7,569
117 194 264 475 578 777 1,232 1,040 1,416 1,516 1,931 1,932 1,726 1,940 1,416 1,516 1,931 1,932 1,726 1,935 1,935 1,235 1,935 1,235 1,935 1,235 1,935	172 194 264 475 578 777 1222 146 146 146 146 2171 2898 3184 3140 3203 3164 1008 241 385 589 681 702 681 1088 1585 1,755 2,149 1,891 1,008 1,755 2,149 1,891 1,008 1,755 1,474 1,004 1,755 1,474 1,004 1,755 1,474 1,004 1,755 1,474 1,004 1,755 1,474 1,004 1,755 1,474 1,004 1,755 1,474 1,004 1,755 1,474 1,004 1,755 1,400 1,755 1,400 1,755 1,400 1,400 1,575 1,400 1,400 1,575 1,400 1,400 1,575 1,400	Ohina	523	472	529	642	1,404	1,558	1,281	1,605	1,615	1,535	1,250	1,571	1,942	2,613	2,936	3,403
280, 897 3164 324 324 324 325 525 321 326 318 318 3140 3203 3144 2247 3156 3248 3248 3244 325 32	184 2847 4849 6672 1046 1702 2861 3140 1755 2149 1881 1.008 1881 1.008 1881 1.008 1881 1.008 1881 1.008 1881 1.008 1881 1.008 1881 1.008	South Korea	172	194	264	475	218	777	1,232	1,040	1,416	1,518	1,931	2,082	1,795	3,102	4,813	5,578
188 241 353 539 531 702 681 1,66 1,65 1,75 5149 1,531 1,006 1,266 290,897 316,247 334,407 386,048 431,324 442,150 458,007 454,986 518,277 566,090 578,249 511,493 611,438 614,213 87,355 92,424 100,495 106,308 421,524 125,609 97,200 115,775 110,403 115,778 134,443 137,208 87,385 92,424 100,495 106,308 421,502 124,40 125,609 97,200 115,778 140,403 15,778 134,443 137,208 87,385 92,424 100,495 106,308 421,73 145,809 5,720 14,807 14,809 5,720 14,807 14,809 15,817 14	188 244 385 589 651 702 661 1068 1,755 1,772 1,900	Taiwan	314	387	449	672	1,045	1,149	2,171	2,898	3,181	3,140	3,203	3,164	2,847	3,156	3,059	3,456
290 188 224 384 525 331 276 382 777 881 1,735 1,742 1,900 1,266 290,897 316,247 384,407 365,048 43,124 442,150 458,007 454,985 518,277 566,090 578,249 611,493 610,338 614,213 3,335 3,429 1,260 4577 4,899 578,270 678,249 611,493 610,388 614,213 8,335 3,429 1,269 4,577 4,689 578,240 107,331 614,218 37,00 8,489 3,590 37,00 107,331 614,218 37,00 8,489 3,590 37,00 107,331 614,218 37,00 8,449 3,50 36,51 8,449 3,50 36,51 8,449 8,50 8,449 3,50 36,51 8,449 3,50 36,51 8,449 3,50 36,51 36,51 36,51 36,51 36,51 36,51 36,51 36,51 36,51 36,51	296 188 234 384 525 331 277 881 1,735 1,742 1,903 290,897 316,247 334,407 385,048 431,324 442,160 458,007 45,486 518,277 556,090 578,249 611,493 610,338 68 87,335 3,429 3,429 4,209 4209 45,17 48,986 518,277 556,090 578,249 611,493 610,338 610,338 68 7,807 13,443 34,437 34,437 34,437 34,407	Singapore	188	241	353	539	631	702	681	1,068	1,563	1,755	2,149	1,831	1,008	2,001	1,684	1,927
Communications equipment 290,887 316,247 334,407 365,048 442,126 456,007 454,386 518,277 566,090 578,249 611,439 611,438 614,213 87,385 22,424 100,486 166,308 124,240 125,680 77,20 107,136 110,403 115,578 120,187 34,493 317,208 87,385 22,424 100,486 166,308 126,240 124,240 125,680 107,001 11,388 13,493 13,443 13,493 13,493 13,443 13,443 13,414 13,443 13,444 13,444 13,444 13,444	Communications equipment 290.897 316_247 334_407 366_048 431_324 442_160 458_007 454_386 518_277 566_090 578_249 611_489 610_338 6 87.385 22_424 100_495 106_308 126_220 124_240 124_240 156_600 97_200 107_135 110_408 150_208 134_343 134_344 134_349 141_490 156_200 97_200 107_135 110_408 156_208 150_208 150_208 159_200 197_347 134_349	Hong Kong	246	188	234	394	525	331	276	382	777	881	1,735	1,742	1,903	1,265	1,599	1,805
290.887 316,247 334,407 386,048 443,260 458,007 454,985 518,277 556,090 578,249 611,483 610,338 614,213 87,355 3,424 100,485 106,308 126,009 125,609 97,200 107,135 116,403 103,187 134,943 137,208 87,385 3,429 3,429 3,429 3,429 37,412 36,869 6,139 110,403 15,518 139,43 137,208 8,498 8,498 8,781 10,437 14,439 13,493 13,493 13,208 14,409 14,412 14,412 14,526 14,900 13,41 17,856 13,893 14,412 14,414 17,814 17,856 13,893 14,412 14,424 17,856 14,414 14,	87.355 92,424 100,495 106,308 126,020 124,240 125,699 97,200 107,135 110,403 115,778 17,101 20,187 110,403 115,778 17,101 20,187 110,403 115,778 17,101 20,187 110,403 115,778 17,101 20,187 110,403 115,778 17,101 20,187 110							Com	nunication	s equipme	Ħ							
290 897 316,247 336,048 431,224 42,150 45,800 516,277 566,090 517,224 611,483 611,1483 611,1483 610,338 614,213 87,355 3,249 3,489 4,510 15,240 15,260 17,201 17,377 17,378 17,378 17,378 17,304 18,389 17,200 17,377 19,425 208,003 27,001 17,377 19,425 208,003 27,001 18,481 17,304 18,482 <td< th=""><th>200 887 316,247 384,407 365,048 41,324 424,150 486,007 454,986 518,277 556,090 578,249 611,488 610,338 610,348 610,338 610,348 610,338 610,348 <th< th=""><th>Production</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<></th></td<>	200 887 316,247 384,407 365,048 41,324 424,150 486,007 454,986 518,277 556,090 578,249 611,488 610,338 610,348 610,338 610,348 610,338 610,348 <th< th=""><th>Production</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>	Production																
87,355 92,424 100,436 106,308 126,020 124,240 125,609 97,200 107,135 110,405 115,678 120,187 134,93 137,208 87,385 3,429 3,429 4,517 4,617 4,689 5,684 6,617 6,737 7,200 89,96 34,47 11,62 227,701 20,318 13,428 34,48 13,48 14,48 14,48 17,48 17,48 13,48 13,48 14,48 17,48 17,48 17,49 17,49 17,49 18,43 13,48 13,48 14,48 17,44 17,49 17,49 17,49 17,49 17,49 17,49 17,49 17,49 17,49 17,49 <	87,385 92,424 100,496 106,308 126,020 4577 4,899 87,200 107,136 110,408 115,76 120,187 139,896 87,385 34,29 34,25 3,428 3,429 3,425 3,429 <th>All countries^a</th> <th>290,897</th> <th>316,247</th> <th>334,407</th> <th>365,048</th> <th>431,324</th> <th>442,150</th> <th>458,007</th> <th>454,985</th> <th>518,277</th> <th>556,090</th> <th>578,249</th> <th>611,493</th> <th>610,338</th> <th>614,213</th> <th>680,801</th> <th>744,334</th>	All countries ^a	290,897	316,247	334,407	365,048	431,324	442,150	458,007	454,985	518,277	556,090	578,249	611,493	610,338	614,213	680,801	744,334
3,335 3,425 3,425 3,425 3,425 3,425 3,425 3,425 3,425 3,425 3,425 3,425 3,425 3,425 3,425 4,517 4,839 5,684 6,133 6,671 6,587 7,200 8,986 8,440 27,884 29,829 12,282 12,282 12,280 12,766 14,900 15,381 15,847 17,566 19,390 27,107 20,3161 18,930 11,223 12,282 12,930 12,766 14,900 15,381 15,847 17,566 19,390 21,102 23,101 23,148 18,489 17,104 16,274 17,104 17,266 19,390 21,102 24,218 23,220 24,218 23,220 24,218 23,220 26,609 34,41 1,104 12,747 37,478 38,747 38,800 27,103 20,318 38,408 38,900 38,400 38,400 38,400 38,400 38,400 38,400 38,400 38,400 38,400 38,400	3,335 3,429 3,428 4,517 4,839 5,694 6,133 6,671 6,587 7,220 8,986 8,834 103,842 103,842 15,469 155,469 150,033 15,2510 17,77 14,238 26,773 27,701 20,318 11,223 12,282 12,786 14,603 15,381 15,847 17,356 19,290 21,122 22,340 24,218 23,252 11,223 12,282 12,786 14,900 15,881 15,847 17,356 21,102 23,404 24,118 23,242 25,892 6,866 9,319 17,104 16,274 19,161 27,477 31,483 28,273 6,618 8,373 17,104 16,274 19,161 27,477 31,483 28,293 31,483 <td>United States</td> <td>87,355</td> <td>92,424</td> <td>100,495</td> <td>106,308</td> <td>126,020</td> <td>124.240</td> <td>125,609</td> <td>97,200</td> <td>107,135</td> <td>110,403</td> <td>115,578</td> <td>120,187</td> <td>134,943</td> <td>137.208</td> <td>157,579</td> <td>196,082</td>	United States	87,355	92,424	100,495	106,308	126,020	124.240	125,609	97,200	107,135	110,403	115,578	120,187	134,943	137.208	157,579	196,082
87,834 103,847 11,155 123,447 15,674 153,469 150,053 187,771 194,236 208,703 227,701 203,181 183,905 17,867 29,862 31,232 34,781 43,781 43,781 43,781 43,781 183,905 55,766 17,280 12,322 12,320 12,766 19,400 15,814 17,814 17,814 18,825 20,404 21,101 21,320 18,828 51,935 51,942 1,2801 12,290 13,465 14,804 17,735 17,814 17,831 18,935 20,404 21,101 21,320 18,948	87.834 103,847 151,674 153,489 150,531 162,510 178,777 194,236 206,703 227,701 203,181 27,887 208,293 31,288 34,683 35,265 37,412 36,889 39,401 43,781 48,784 20,7701 203,188 12,801 12,706 13,486 14,800 15,384 17,381 18,935 20,404 21,101 21,320 19,482 19,313 12,801 12,706 13,486 14,804 17,735 17,104 17,382 17,104 21,101 21,101 21,322 19,393 19,373 19,393 19,313 19,390 20,404 21,101 21,322 19,313 19,390 6,017 7,487 17,487 7,788 8,781 8,893 12,886 15,489 17,487 17,487 17,487 17,487 17,489 18,482 19,482 19,413 17,413 17,481 17,488 18,983 12,886 15,489 17,488 14,488 17,488 18,482	Canada	3,335	3,429	3,425	3,493	4,209	4,517	4,839	5,694	6,133	6,671	6,597	7,920	8,985	8,449	9,163	9,725
27,867 29,829 31,286 34,603 36,261 36,809 39,401 43,781 48,374 22,638 51,935 55,766 57,802 12,322 13,422 12,322 13,422 14,804 17,735 17,814 17,831 14,934 14,944 14,944 14,944 14,944 14,944 14,944 14,944 14,944 14,944 14,768 3,449 2,140 2,140 2,140 2,140	27,867 29,829 31,286 34,603 36,412 36,809 39,401 43,781 48,374 52,639 51,385 51,386 31,488 51,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 15,381 17,336 19,360 21,101 21,320 19,482 19,313 5,773 5,664 5,890 6,866 6,319 17,104 16,274 19,161 27,477 31,198 25,943 25,996 31,431 6,667 5,900 5,669 6,606 6,032 16,742 19,161 27,477 31,198 25,943 29,432 1,488 3,116 3,907 5,886 9,319 17,104 16,274 19,161 27,477 31,198 25,948 21,488 21,488 4,078 5,990 5,382 1,488 1,476 4,669 36,485	Japan	87,834	103,847	111,155	123,447	151,674	153,469	150,053	152,510	178,777	194,236	208,703	227,701	203,181	183,903	201,403	198,080
11,223 12,322 12,930 12,766 14,900 15,847 17,356 19,590 21,162 23,340 24,218 23,252 21,948 21,922 19,488 19,488 19,191 21,200 19,482 19,191 19,200 19,488 19,191 21,020 19,482 19,313 18,488 19,488 19,191 21,040 21,101 21,220 19,482 19,313 18,488 19,488 19,488 20,404 21,101 21,220 19,488 19,488 19,488 21,431 42,977 78,787 18,273 20,409 20,386 21,431 42,977 78,788 17,488 19,411 27,477 31,198 23,943 25,996 31,431 42,977 42,978 17,488 17,485 18,273 20,499 20,499 17,488 40,476 4,659 3,648 20,498 17,488 4,476 4,659 3,648 2,619 20,330 20,438 2,476 2,476 4,659 3,648 2,619 3,428 2,478	11,223 12,322 12,932 12,765 14,900 15,847 17,356 19,590 21,162 23,340 24,218 23,252 12,801 12,705 13,465 14,804 17,735 17,814 17,835 18,935 20,404 21,101 21,320 19,478 18,313 6,667 5,664 5,896 6,866 9,319 17,104 16,274 19,161 27,477 31,198 23,943 25,996 31,431 3,116 3,907 3,956 6,866 9,319 17,104 16,274 19,181 23,443 25,996 31,431 2,027 2,193 5,236 6,655 8,188 10,782 18,698 16,699 20,499	Germany ^b	27,867	29,829	31,258	34,603	36,251	35,366	37,412	36,809	39,401	43,781	48,374	52,638	51,935	55,766	61,628	64,086
12,801 12,706 13,465 14,804 17,735 17,814 17,831 18,935 20,404 21,101 21,320 19,482 19,313 18,488 6,677 5,684 5,880 6,442 6,090 6,003 6,612 7,467 7,789 8,791 8,797 8,890 7,497 7,740 10,724 19,041 7,789 8,791 8,239 13,431 4,290 7,890 8,789 12,890 15,549 17,835 20,409 20,885 21,439 20,499 20,886 21,429 21,429 20,499 20,886 20,488 12,886 15,549 17,825 18,899 20,380 20,499 21,499 20,380 20,499 20,885 20,498 10,718 4,675 5,334 7,968 10,718 6,612 7,467 4,659 3,689 20,489 20,499 20,499 20,499 20,499 20,499 20,499 20,499 20,499 20,499 20,499 20,499 20,499 20,499 20,499	12,801 12,706 13,465 14,804 17,735 17,814 17,831 18,935 20,404 21,101 21,320 19,482 19,313 5,773 5,654 5,880 6,442 6,090 6,003 6,612 7,467 7,769 8,791 8,791 8,794 20,496 1,394 1,394 20,396 3,431 1,301 4,206 6,612 7,467 7,769 8,791 8,791 8,791 8,791 8,791 8,794 20,499 20,637 8,690 9,003 1,101 27,467 3,148 29,494 20,499 20,380 20,637 1,240 1,788 6,178 8,791 20,499 1,788 1,394 1,788 1,394 20,499 20,380 20,637 20,499 20,380 20,637 20,499 20,380 20,637 20,499 20,380 20,494 20,498 20,498 20,498 20,498 20,498 20,498 20,498 20,498 20,498 20,498 20,498 20,498 20	France	11,223	12,322	12,930	12,766	14,900	15,381	15,847	17,356	19,590	21,162	23,340	24,218	23,252	21,942	23,970	25,160
5,773 5,664 5,880 6,432 6,090 6,012 7,467 7,769 8,791 8,923 8,977 8,660 7,877 3,166 5,900 5,669 6,666 9,319 17,104 16,744 19,161 27,477 31,198 23,937 25,977 3,166 5,900 5,666 9,366 9,678 17,326 18,781 18,969 20,489 21,284 2,166 5,193 5,225 6,665 8,518 8,839 12,896 10,178 6,403 6,617 6,896 20,489 20,380 20,637 25,499 2,227 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,436 6,617 6,039 6,617 6,638 1,646 1,782 18,689 20,493 6,639 20,637 25,499 1,782 18,689 20,493 6,637 25,499 1,387 1,476 4,659 3,668 2,016 1,496 1,476 4,659	5,773 5,664 5,880 6,432 6,090 6,012 7,467 7,769 8,791 8,923 8,977 8,560 6,667 5,900 5,686 6,432 6,090 6,012 7,467 7,769 8,791 8,923 8,977 8,566 9,366 9,866 9,31 17,404 16,274 19,161 27,477 31,183 20,409 20,489 20,489 12,896 15,549 17,825 18,581 18,969 20,489 20,687 2,227 2,518 2,327 3,418 4,075 5,344 7,968 10,178 6,439 10,489 10,478 6,439 1,476 4,659 3,668 2,616 1,441 4,075 5,344 7,968 10,714 12,290 11,327 12,0119 14,659 16,670 10,714 12,290 11,327 12,0119 14,659 3,668 2,616 1,441 4,075 5,344 7,968 10,714 12,0149 17,829 14,676 4,659 3,668	United Kingdom	12,801	12,706	13,465	14,804	17,735	17,814	17,831	18,935	20,404	21,101	21,320	19,482	19,313	18,468	21,614	23,346
6.667 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 31,198 23,943 25,996 31,431 42,977 3,116 3,907 5,382 7,407 7,348 10,752 14,904 17,635 18,273 20,409 20,849 21,883 24,296 2,377 2,387 2,384 7,986 10,775 6,665 3,668 2,616 1,849 2,156 2,137 2,546 2,154 2,893 2,702 3,163 3,200 2,382 3,335 4,476 4,659 3,668 2,616 1,849 2,156 2,131 60,780 68,814 69,104 79,904 97,205 98,683 105,677 120,119 14,659 3,668 2,616 1,849 2,156 2,131 7,586 7,947 4,659 3,668 2,616 1,349 2,156 2,131 1,882 1,327 12,011 14,659 3,668 2,616 1,494	6,667 5,900 5,569 6,886 9,319 17,104 16,274 19,161 27,477 31,198 23,943 25,996 31,431 3,116 3,907 5,586 6,886 9,319 17,104 16,274 19,161 27,477 31,198 23,943 25,996 31,431 4,806 5,193 5,325 6,655 6,655 8,214 4,075 5,344 7,968 10,778 6,667 1,899 7,204 17,68 2,616 1,899 2,166 3,668 2,616 1,849 2,156 2,170 3,689 2,324 7,688 10,718 6,659 3,668 2,616 1,849 2,156 2,616 1,849 2,156 2,166 3,668 3,668 3,475 3,326 4,476 4,659 3,668 2,616 1,184 2,156 1,164 1,178 1,178 1,178 1,178 1,178 1,178 1,178 1,178 1,178 1,178 1,178 1,141 1,141 1,141	Italy	5,773	5,654	5,880	6,432	060'9	6,003	6,612	7,467	7,769	8,791	8,923	8,977	8,560	7,877	8,472	8,991
3,116 3,907 3,950 5,382 7,407 7,348 10,752 14,904 17,635 18,273 20,409 20,845 21,883 24,296 4,806 5,193 5,235 6,655 8,518 8,839 12,896 10,718 6,403 6,617 6,892 7,271 7,307 2,327 2,318 2,321 3,013 4,214 4,075 5,334 7,968 10,718 6,403 6,617 6,892 7,271 7,367 2,327 2,318 2,328 3,606 2,382 3,668 2,616 1,849 2,156 2,131 60,780 68,814 69,104 79,04 97,205 98,698 10,677 120,119 14,589 16,038 179,309 197,561 1,849 2,136	3,116 3,907 3,956 5,362 7,407 7,348 10,752 14,904 17,635 18,273 20,409 20,845 21,883 4,806 5,193 5,235 6,655 8,518 8,839 12,896 15,549 17,825 18,581 18,699 20,380 20,637 2,154 2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,403 6,617 6,892 7,271 2,154 2,861 3,200 2,382 3,335 4,476 4,659 3,668 2,616 1,849 2,156 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 14,589 165,038 17,189 1,1849 2,166 1,949 2,166 3,008 3,425 4,381 2,166 2,699 3,008 3,425 4,381 2,166 2,699 3,008 3,627 4,167 2,741 2,648 1,648 1,648 1,648 <td>China</td> <td>6,667</td> <td>5,900</td> <td>5,569</td> <td>998'9</td> <td>9,319</td> <td>17,104</td> <td>16,274</td> <td>19,161</td> <td>27,477</td> <td>31,198</td> <td>23,943</td> <td>25,996</td> <td>31,431</td> <td>42,977</td> <td>47,068</td> <td>54,174</td>	China	6,667	5,900	5,569	998'9	9,319	17,104	16,274	19,161	27,477	31,198	23,943	25,996	31,431	42,977	47,068	54,174
4,806 5,133 5,235 6,655 8,518 8,839 12,896 15,549 17,825 18,581 18,969 20,380 20,637 25,459 7,877 2,927 2,545 2,277 2,137 7,367 7,367 7,367 7,367 7,367 7,367 7,367 7,367 7,367 7,367 7,377 7,367 7,367 7,367 7,368 7,368 7,968 7,974 1,272 1,349 2,156 2,131 7,368 7,368 7,969 3,068 2,616 1,894 2,156 2,131 2,196 2,777 2,206 2,699 3,008 3,522 4,338 4,318 4,318 8,118 9,118 8,118 9,118 8,118 9,118 1,118 1,118	4,806 5,193 5,235 6,655 8,518 8,839 12,896 15,549 17,825 18,561 18,999 20,380 20,637 2,327 2,154 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,617 6,617 6,892 7,271 2,154 2,216 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,617 <t< td=""><td>South Korea</td><td>3,116</td><td>3,907</td><td>3,950</td><td>5,362</td><td>7,407</td><td>7,348</td><td>10,752</td><td>14,904</td><td>17,635</td><td>18,273</td><td>20,409</td><td>20,845</td><td>21,883</td><td>24,296</td><td>28,107</td><td>31,880</td></t<>	South Korea	3,116	3,907	3,950	5,362	7,407	7,348	10,752	14,904	17,635	18,273	20,409	20,845	21,883	24,296	28,107	31,880
2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,403 6,617 6,882 7,271 7,367 2,154 2,893 2,702 3,163 3,200 2,382 3,335 4,476 4,659 3,668 2,616 1,849 2,156 2,131 60,780 68,814 69,104 79,904 97,205 98,683 105,677 120,119 145,809 165,038 179,309 197,561 21,136 2,136 7,588 7,965 7,942 1,518 2,225 2,319 2,195 2,277 2,209 3,008 3,453 3,737 35,272 44,623 46,281 48,687 47,377 45,116 8,952 2,340 2,199 35,737 35,272 41,207 44,623 46,281 48,687 47,377 44,044 8,152 2,446 3,401 3,911 3,883 4,560 5,247 2,289 3,659 3,741 4,072 4,603 <th>2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,403 6,617 6,892 7,271 2,154 2,893 2,702 3,163 3,200 2,382 3,335 4,476 4,659 3,668 2,016 1,849 2,156 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 2,156 7,588 7,965 7,942 10,711 12,225 2,219 2,195 2,277 2,206 2,699 3,008 3,627 4,689 3,008 3,627 4,887 19,470 2,741 26,994 3,008 3,627 4,689 3,008 3,627 4,682 19,470 46,689 3,008 3,627 4,787 46,689 3,008 3,627 4,887 19,470 46,689 3,689 3,627 4,689 46,881 13,827 3,827 4,689 4,689 4,</th> <th>Taiwan</th> <th>4,806</th> <th>5,193</th> <th>5,235</th> <th>6,655</th> <th>8,518</th> <th>8,839</th> <th>12,896</th> <th>15,549</th> <th>17,825</th> <th>18,581</th> <th>18,969</th> <th>20,380</th> <th>20,637</th> <th>25,459</th> <th>24,074</th> <th>26,819</th>	2,327 2,518 2,321 3,013 4,214 4,075 5,334 7,968 10,178 6,403 6,617 6,892 7,271 2,154 2,893 2,702 3,163 3,200 2,382 3,335 4,476 4,659 3,668 2,016 1,849 2,156 60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 2,156 7,588 7,965 7,942 10,711 12,225 2,219 2,195 2,277 2,206 2,699 3,008 3,627 4,689 3,008 3,627 4,887 19,470 2,741 26,994 3,008 3,627 4,689 3,008 3,627 4,682 19,470 46,689 3,008 3,627 4,787 46,689 3,008 3,627 4,887 19,470 46,689 3,689 3,627 4,689 46,881 13,827 3,827 4,689 4,689 4,	Taiwan	4,806	5,193	5,235	6,655	8,518	8,839	12,896	15,549	17,825	18,581	18,969	20,380	20,637	25,459	24,074	26,819
60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,355 7,588 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 37,829 957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,381 4,313 18,962 23,901 23,540 27,309 35,772 2,177 2,206 2,699 3,008 3,522 4,381 4,313 18,962 23,901 23,540 27,126 35,737 35,727 41,207 44,623 46,281 48,687 47,377 45,116 1,52 2,445 2,560 3,141 3,911 3,883 4,560 5,234 5,591 6,418 7,461 7,517 8,436 2,141 2,586 2,594 <td< th=""><th>60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 21,166 2,166 2,166 2,166 2,166 2,166 2,166 2,166 3,668 2,616 1,849 2,156 2,156 2,166 3,608 3,617 3,425 3,425 3,426 3,277 2,206 2,699 3,008 3,627 4,1207 44,623 46,281 48,687 3,425 4,337 1,896 2,390 2,730 35,172 35,996 35,737 35,772 2,206 2,699 3,008 3,527 4,337 1,896 2,390 2,746 8,199 8,810 9,172 1,417 12,408 12,332 13,818 13,877 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 14,623 46,281 47,818 7,461 7,517 14,623 46,281 46,28</th><th>Singapore</th><th>2,327</th><th>2,518</th><th>2,321</th><th>3,013</th><th>4,214</th><th>4,075</th><th>5,334</th><th>7,968</th><th>10,178</th><th>6,403</th><th>6,617</th><th>6,892</th><th>7,271</th><th>7,367</th><th>8,179</th><th>9,255</th></td<>	60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 21,166 2,166 2,166 2,166 2,166 2,166 2,166 2,166 3,668 2,616 1,849 2,156 2,156 2,166 3,608 3,617 3,425 3,425 3,426 3,277 2,206 2,699 3,008 3,627 4,1207 44,623 46,281 48,687 3,425 4,337 1,896 2,390 2,730 35,172 35,996 35,737 35,772 2,206 2,699 3,008 3,527 4,337 1,896 2,390 2,746 8,199 8,810 9,172 1,417 12,408 12,332 13,818 13,877 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 13,878 14,623 46,281 47,818 7,461 7,517 14,623 46,281 46,28	Singapore	2,327	2,518	2,321	3,013	4,214	4,075	5,334	7,968	10,178	6,403	6,617	6,892	7,271	7,367	8,179	9,255
60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,355 2 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 37,829 37,829 25,71 22,540 27,309 35,172 35,996 35,737 241,207 44,623 46,281 48,687 47,377 45,116 6,192 27,409 22,445 27,260 2,699 3,008 3,618 4,313 13,627 14,404 12,388 2,594 2,715 3,299 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,345 1,740 2,997 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 68 90 103 150 371 107 292 545 1,501 1,345 3,068 3,409 3,508 3,508 3,509 3,508 3,409 1,301 1,341 1,507 11,641 13,567 14,408 15,001 1,345 1,349 2,000 2,699 3,618 4,349 5,000 1,648 2,721 2,424 2,723 3,253 2,669 3,663 3,661 5,691 11,507 11,641 13,567 14,408 15,061 2,708 2,703 2,444 3,281 3,	60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 23,425 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 967 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,006 2,699 3,008 3,622 4,381 1,645 2,340 27,309 35,172 35,996 35,772 41,207 44,623 46,281 48,687 47,377 2,195 2,445 2,600 3,008 3,401 3,911 3,650 5,234 5,591 6,174 7,461 7,517 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 1,355 1,448 1,740 2,31 2,31 2,327	Hong Kong	2,154	2,893	2,702	3,163	3,200	2,382	3,335	4,476	4,659	3,668	2,616	1,849	2,156	2,131	2,271	2,487
60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 241,355 2 7,588 7,985 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,883 29,47 33,425 37,829 18,962 23,901 23,540 27,309 35,737 35,272 41,207 44,623 46,281 48,887 45,116 44,141 46,887 46,281 46,887 47,377 44,144 46,281 46,281 46,281 46,281 46,281 43,14 44,144 46,281 46,281 46,281 46,418 43,14 46,144 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,414 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281 46,281	60,780 68,814 69,104 79,904 97,205 98,693 105,677 120,119 145,809 165,038 179,309 197,561 216,166 2,588 7,988 7,985 7,988 7,988 7,988 7,988 7,989 3,727 12,703 14,882 19,470 22,741 26,583 29,547 33,425 4,381 33,425 4,623	Exports																
7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 37,829 957 1,372 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,311 18,962 23,901 23,540 27,309 35,172 35,996 35,777 2,206 2,699 3,008 3,522 4,317 45,116 6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 14,408 14,688 14,377 14,078 46,691 6,274 37,617 46,116 43,141 3,221 48,817 44,044 43,141 15,232 13,627 14,444 43,078 14,072 46,03 6,227 7,593 8,555 9,478 9,778 12,716 13,471 14,044 43,00 3,00 3,411 3,221 3,499 3,618 4,30 4,60 3,618 3	tes 7,588 7,965 7,942 10,711 12,290 11,327 12,703 14,882 19,470 22,741 26,583 29,547 33,425 34,25 957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,381 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 44,623 46,281 48,687 47,377 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 44,623 46,281 48,687 47,377 18,962 23,901 2,260 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 2,195 2,445 2,600 3,008 3,401 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 2,195 2,445 2,600 2,696 3,627 2,470 2,954 3,141 3,221 3,399 3,618 2,195 1,438 2,721 2,424 2,793 3,228 3,664 5,865 8,486 9,664 10,523 12,070 2,107 1,901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,070	All countries ^a	60,780	68,814	69,104	79,904	97,205	98,693	105,677	120,119	145,809	165,038	179,309	197,561	216,166	241,355	293,514	336,549
957 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,811 4,313 18,962 23,901 23,540 27,309 35,172 35,737 35,272 41,207 44,623 46,281 48,867 47,377 45,116 1,522 6,489 7,146 8,199 8,810 9,027 9,612 11,417 12,408 13,322 13,627 14,404 2,145 2,600 3,008 3,401 3,911 3,853 4,603 6,227 7,593 8,555 9,478 12,776 1,355 1,438 1,645 1,740 2,097 2,310 2,37 2,470 2,954 3,141 3,221 3,499 3,618 4,300 1,355 1,438 1,645 1,740 2,937 2,470 2,954 3,141 3,221 3,399 3,618 4,300 1,355 1,934 2,006 2,696 3,67 5,270 7,655 <th>957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,381 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 44,623 46,281 48,687 47,377 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 44,623 46,281 48,687 47,377 18,962 2,594 2,716 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 3,401 2,195 1,445 1,984 2,006 2,690 3,007 2,191 1,507 2,954 3,141 3,221 3,399 3,618 1,645 1,984 2,006 2,696 3,627 3,644 5,385 8,100 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,049 11,702 13,255 1,278 1,981 2,202 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,070</th> <th>United States</th> <th>7,588</th> <th>7,965</th> <th>7,942</th> <th>10,711</th> <th>12,290</th> <th>11,327</th> <th>12,703</th> <th>14,882</th> <th>19,470</th> <th>22,741</th> <th>26,583</th> <th>29,547</th> <th>33,425</th> <th>37,829</th> <th>46,960</th> <th>29,055</th>	957 1,272 1,324 1,518 2,225 2,319 2,195 2,277 2,206 2,699 3,008 3,522 4,381 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 44,623 46,281 48,687 47,377 18,962 23,901 23,540 27,309 35,172 35,996 35,737 35,272 41,207 44,623 46,281 48,687 47,377 18,962 2,594 2,716 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 3,401 2,195 1,445 1,984 2,006 2,690 3,007 2,191 1,507 2,954 3,141 3,221 3,399 3,618 1,645 1,984 2,006 2,696 3,627 3,644 5,385 8,100 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,641 13,507 11,049 11,702 13,255 1,278 1,981 2,202 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,070	United States	7,588	7,965	7,942	10,711	12,290	11,327	12,703	14,882	19,470	22,741	26,583	29,547	33,425	37,829	46,960	29,055
18,962 23,901 23,540 27,309 35,772 35,272 41,207 44,623 46,281 48,687 47,377 45,116 6,152 6,883 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 14,404 2,145 2,645 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,617 8,632 2,141 2,388 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,997 2,310 2,337 2,470 2,954 3,141 3,221 3,999 3,618 4,300 1,645 1,984 2,006 2,696 3,57 3,504 5,270 7,655 10,181 11,507 11,644 13,567 14,408 15,061 <td< th=""><th>18,962 23,901 23,540 27,309 35,77 35,272 41,207 44,623 46,281 48,687 47,377 4,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,888 13,627 3,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,517 3dom 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 3marrow 1,355 1,436 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 3marrow 1,645 1,984 2,006 2,696 3,674 5,770 7,655 10,181 11,507 14,994 3marrow 2,127 2,424 2,783 2,669 3,664 5,385 8,</th><th>Canada</th><th>957</th><th>1,272</th><th>1,324</th><th>1,518</th><th>2,225</th><th>2,319</th><th>2,195</th><th>2,277</th><th>2,206</th><th>2,699</th><th>3,008</th><th>3,522</th><th>4,381</th><th>4,313</th><th>2,008</th><th>5,945</th></td<>	18,962 23,901 23,540 27,309 35,77 35,272 41,207 44,623 46,281 48,687 47,377 4,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,888 13,627 3,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,517 3dom 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 3marrow 1,355 1,436 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 3marrow 1,645 1,984 2,006 2,696 3,674 5,770 7,655 10,181 11,507 14,994 3marrow 2,127 2,424 2,783 2,669 3,664 5,385 8,	Canada	957	1,272	1,324	1,518	2,225	2,319	2,195	2,277	2,206	2,699	3,008	3,522	4,381	4,313	2,008	5,945
6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 14,404 2,195 2,445 2,660 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 8,632 2,141 2,888 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,488 2,721 2,424 2,793 3,253 2,669 3,864 5,385 8,409 9,157 10,049 11,702 13,255 15,957 2,177 1,981 2,083 2,207 2,764 2,625 3,664 5,385 8,486 9,654 11,702 13,255 15,957 1,901 2,08 2,093 2,444 3,281 3,77 3,518 5,661 7,655 8,486 9,664 11,570 13,255 15,957	6,152 6,893 7,126 7,146 8,199 8,810 9,027 9,612 11,417 12,408 12,332 13,838 13,627 3,008 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 3,000 2,195 2,145 2,000 2,097 2,110 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,94 4,94 2,700 2,097 2,710 7,292 6,55 10,181 11,607 11,641 13,57 14,08 2,721 2,793 3,253 2,669 3,664 5,385 8,040 9,157 10,049 11,702 1,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,070	Japan	18,962	23,901	23,540	27,309	35,172	35,996	35,737	35,272	41,207	44,623	46,281	48,687	47,377	45,116	47,414	51,308
2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 8,632 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,590 7,95 8,157 1,989 1,170 13,255 15,941 2,070 2,087 2,444 5,385 8,555 8,486 9,664 1,673 1,070 14,773 1,971 2,783 3,281 3,281 3,561 16,941 1,705 13,255 15,941 1,001 2,08 2,09 2,09 2,09 2,09 2,09 2,09 2,09 2,09	2,195 2,445 2,600 3,008 3,401 3,911 3,853 4,560 5,234 5,591 6,418 7,461 7,517 gdom 2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,277 7,593 8,555 9,478 9,778 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 as	Germany ^b	6,152	6,893	7,126	7,146	8,199	8,810	9,027	9,612	11,417	12,408	12,332	13,838	13,627	14,404	18,288	19,840
2,141 2,368 2,594 2,715 3,228 3,741 4,072 4,603 6,227 7,593 8,555 9,478 9,778 12,716 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 6,90 103 150 371 107 292 545 1,501 1,345 3,068 3,469 4,494 5,000 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,783 3,253 2,669 3,869 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,777 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,167 10,049 11,702 13,255 15,957 1,901 2,703 2,444 3,281 3,77 3,518 5,611 7,655 8,486 9,664 10,523 1,207 1,4703	gdom 2,141 2,564 2,715 3,228 3,741 4,072 4,603 6,27 7,593 8,555 9,478 9,778 300 1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 300 103 150 3,71 107 292 545 1,501 1,345 3,068 3,489 3,618 4494 2,006 2,696 3,627 3,504 5,700 7,655 10,181 11,507 11,641 13,567 14,408 300 2,488 2,721 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 300 2,127 2,793 2,764 2,625 3,664 5,386 8,406 9,157 10,049 11,702 13,255 300 1,901 2,203 2,444 3,281 3,157 3,518 5,061	France	2,195	2,445	2,600	3,008	3,401	3,911	3,853	4,560	5,234	5,591	6,418	7,461	7,517	8,632	9,785	11,095
1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 4,300 68 90 103 150 371 107 292 545 1,501 1,345 3,068 3,469 4,94 5,000 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,148 2,721 2,424 2,793 3,253 2,669 3,869 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,177 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,167 10,049 11,702 13,255 15,957 1901 2,08 2,09 2,09 3,81 3,281 5,611 7,655 8,040 9,167 10,049 11,702 13,255 15,707 14,703	1,355 1,438 1,645 1,740 2,097 2,310 2,337 2,470 2,954 3,141 3,221 3,399 3,618 3,118 3,119	United Kingdom	2,141	2,368	2,594	2,715	3,228	3,741	4,072	4,603	6,227	7,593	8,555	9,478	9,778	12,716	15,532	17,613
68 90 103 150 371 107 292 545 1,501 1,345 3,068 3,469 4,494 5,000 1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,148 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,177 1,989 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 1901 2,208 2,207 2,324 3,281 3,565 16,977 14,708 10,491 11,702 13,255 15,977 14,703 14	68 90 103 150 371 107 292 545 1,501 1,345 3,068 3,499 4,494 1,901 1,345 1,501 1,505 1,501 1,505 1,501 1,505 1,405 1,406 1,406 1,505 1,507 1,507 2,764 2,659 3,864 5,385 8,040 9,157 10,049 11,702 13,255 1,501 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,070	Italy	1,355	1,438	1,645	1,740	2,097	2,310	2,337	2,470	2,954	3,141	3,221	3,399	3,618	4,300	4,758	5,375
1,645 1,984 2,006 2,696 3,627 3,504 5,270 7,655 10,181 11,507 11,641 13,567 14,408 15,061 2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 1901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,770 14,773	sa	China	89	06	103	150	371	107	292	545	1,501	1,345	3,068	3,469	4,494	2,000	6,889	7,765
2,488 2,721 2,424 2,793 3,253 2,669 3,859 5,902 7,495 8,193 7,781 8,375 9,551 10,941 2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 1901 2,208 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,664 10,523 12,070 14,703		South Korea	1,645	1,984	2,006	2,696	3,627	3,504	5,270	7,655	10,181	11,507	11,641	13,567	14,408	15,061	19,046	22,837
2,127 1,981 1,969 2,207 2,764 2,625 3,664 5,385 8,040 9,157 10,049 11,702 13,255 15,957 15,01 2,017 2,018 2,023 2,444 3,281 3,157 3,518 5,061 7,655 8,486 9,684 10,523 12,070 14,703		Taiwan	2,488	2,721	2,424	2,793	3,253	2,669	3,859	5,902	7,495	8,193	7,781	8,375	9,551	10,941	12,749	14,861
1901 2208 2023 2444 3281 3157 3518 5061 7655 8486 9664 10523 12070 14703	g	Singapore	2,127	1,981	1,969	2,207	2,764	2,625	3,664	5,385	8,040	9,157	10,049	11,702	13,255	15,957	22,812	25,615
50.1.1 0.10.2.1 0.20.0 0.1.0 0.0.0 0.0.0 0.1.0 0		Hong Kong	1,901	2,208	2,023	2,444	3,281	3,157	3,518	5,061	7,655	8,486	9,664	10,523	12,070	14,703	18,117	20,735

56,821 3,481 3,481 15,891 10,825 11,128 4,528 2,722 442 541 59

55,872 3,251 33,796 14,764 10,224 10,402 1,713 4,014 2,505 421 490 56

52,005 3,076 3,076 32,333 13,757 10,002 9,749 1,682 3,577 2,403 422 478 61

51,707 2,913 32,379 12,569 9,206 9,697 2,222 3,690 2,324 404 483 69

48,352 2,787 32,329 13,075 8,336 8,931 2,195 3,770 2,206 376 67

44,918 2,815 32,369 112,725 7,815 8,795 2,379 3,421 2,388 367 367 60

2,655 32,334 13,054 7,315 8,708 1,895 3,942 1,986 358 398 69

152,126 41,405 2,814 31,202 12,009 6,270 8,616 2,041 4,273 2,416 4,273 378 73

43,922 39,300 2,775 30,213 11,794 5,764 8,232 2,980 2,704 1,820 376 69

35,995 2,401 27,708 12,882 5,813 7,674 2,833 1,943 1,748 469 67

32,646 2,228 26,166 13,901 5,639 7,068 2,825 1,411 1,558 379 230 54

123,348 31,160 1,832 25,354 14,096 6,721 3,032 1,678 1,476 338 240 63

117,460 30,258 1,656 24,932 12,716 5,157 6,166 2,935 1,685 1,273 298 178 43

27,924 1,560 23,392 11,917 5,516 5,978 3,074 1,150 1,150 295 60

26,094 1,522 21,561 11,164 4,550 5,447 3,780 921 987 232 139 66

98,776 23,935 1,262 19,704 9,203 3,681 4,331 666 940 208 123

United Kingdom. Germany^b

France

Italy

ChinaSouth Korea

Taiwan

United States Canada

Japan

All countries^a ...

Production

Appendix table 6-5. **Global industry and trade data, by selected countries and industries: 1980-95** (Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Imports All countries ^a	55,727	63,728	63,704	75,089	92,948	94,269	101,323	115,359	141,360	159,787	172,979	191,586	210,245	232,492	283,892	325,907
United States	10,562	13,842	14,661	20,440	29,458	28,897	28,899	29,672	32,147	37,334	35,043	36,932	44,765	48,983	57,347	67,408
Canada	1,862	2,190	2,068	2,558	3,343	2,935	3,426	3,738	4,515	5,157	6,129	7,150	7,292	7,362	9,116	10,970
Japan	1,134	1,257	1,242	1,651	2,110	1,943	2,453	3,303	4,660	6,308	7,493	7,780	8,187	10,631	14,213	17,864
Germany ^b	5,520	5,597	5,500	6,101	6,627	6,892	7,937	9,297	10,558	11,836	15,238	16,863	16,154	16,726	20,387	22,955
France	2,899	3,178	3,243	2,866	3,336	3,443	4,178	4,954	6,542	6,782	7,979	8,427	7,852	8,344	9,762	10,913
United Kingdom	3,075	4,176	4,719	5,143	5,305	5,611	5,905	7,149	9,005	10,513	10,303	10,180	10,638	11,937	13,629	14,711
Italy	2,415	2,306	2,437	2,244	2,714	3,090	3,562	4,537	5,800	6,545	7,470	7,934	7,451	6,316	7,703	8,590
China	510	992	518	720	2,013	4,074	2,340	2,810	4,437	4,249	4,012	4,935	6,463	10,214	12,557	14,319
South Korea	1,109	1,193	1,353	2,037	2,447	2,227	2,739	3,672	4,729	5,056	5,587	6,326	6,691	6,932	8,473	10,039
Taiwan	1,238	1,398	1,274	1,646	2,191	1,861	2,788	4,047	5,239	6,040	6,499	7,339	8,935	9,524	10,631	11,783
Singapore	1,928	2,117	2,318	2,940	3,317	3,090	3,631	4,728	6,405	7,532	9,198	10,640	11,913	14,655	19,883	22,459
Hong Kong	1,717	2,010	1,834	2,351	3,397	2,979	3,127	4,587	7,524	7,499	9,629	11,733	14,527	14,543	17,555	20,005
Apparent consumption																
All countries ^a	304,878	332,593	350,590	385,539	457,555	468,897	485,963	486,205	556,021	598,496	623,419	662,058	668,692	676,892	758,009	842,802
United States	92,798	100,904	109,824	119,569	147,252	145,571	146,040	116,970	126,352	132,664	133,042	137,632	157,714	161,353	184,154	224,877
Canada	4,471	4,657	4,493	4,906	5,874	5,705	6,615	7,723	8,995	9,810	10,483	12,448	13,022	12,612	14,570	15,776
Japan	75,559	88,220	95,788	105,850	129,019	130,088	127,380	131,023	154,478	169,194	183,689	201,279	178,098	162,871	182,354	193,040
Germany ^b	30,023	31,654	32,858	36,791	38,386	37,429	40,403	40,844	43,711	48,830	56,869	61,931	60,640	64,628	72,032	76,126
France	12,529	13,727	14,288	13,453	15,775	15,996	17,240	19,018	22,355	23,910	26,693	27,270	25,693	24,078	26,699	28,125
United Kingdom	14,329	15,172	16,310	17,985	20,708	20,722	20,794	22,759	24,912	26,131	25,449	22,826	22,903	21,243	24,055	25,699
Italy	7,332	7,052	7,279	7,579	7,481	7,635	8,699	10,445	11,704	13,353	14,359	14,765	13,726	11,478	13,172	14,039
China	7,113	6,582	5,991	7,449	10,999	21,082	18,355	21,493	30,608	34,282	25,315	27,964	34,070	48,964	53,848	60,930
South Korea	2,885	3,487	3,676	5,218	6,926	6,755	9,255	12,435	14,213	14,146	16,734	16,396	17,152	19,304	21,528	24,179
Taiwan	3,998	4,357	4,520	6,012	8,042	8,513	12,527	14,777	16,970	17,948	19,150	20,916	21,828	26,148	24,430	26,730
Singapore	2,478	2,981	2,995	4,111	5,225	4,978	5,913	8,211	688'6	6,312	7,450	7,792	8,155	8,742	9,084	10,048
Hong Kong	2,462	3,268	3,040	3,709	4,176	3,035	3,871	5,336	6,327	4,558	4,755	5,371	7,329	5,063	5,724	6,241
						۵	Drugs and medicines	nedicines								

Page 7 of 8

Hong Kong ... Singapore

Science & Engineering Indicators – 1998

Appendix table 6-5. Global industry and trade data, by selected countries and industries: 1980-95

(Millions of 1987 U.S. dollars)

Activity and country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Exports All countries ^a	17,365 2,683	19,856 2,894	21,948 2,996	21,085 3,149	22,010 3,264	23,820 3,251	25,931 3,829	26,271 3,700	30,203 4,307	29,988 3,759	31,134 3,899	34,209 4,086	38,162 4,584	43,509 4,634	47,145 4,838	50,951
Canada Japan	127	187 452	182 451	206 500	184 501	186 555	213 616	237	203 684	177 714	218	225 858	315 970	331 924	420 889	478 960
Germany ^b	2,717	3,211	3,244	3,321	3,602	3,917	4,031	4,049	4,733	4,694	4,706	5,267	5,422	6,033	6,826	7,423
United Kingdom	1,623	1,877	3,617	2,071	2,124	2,309	2,393	2,384	2,598	2,815 3,131	2,860	3,104	3,499	4,094 4.330	4,156	4,445 4,769
Italy	822	965	980	1,032	1,136	1,306	1,256	1,190	1,311	1,187	1,146	1,197	1,712	2,059	2,178	2,373
China	230	240	235	250	276	342	410	433	230	585	648	732	818	807	974	1,075
South Korea	21	30	32	33	38	48	73	75	75	87	95	19	130	134	154	170
Singaporo	728	41	37	38	88 4	31	89	48	57	18	64 777	74 77	98	9 64 49 08	70	71
Hong Kong	152	184	183	190	180	204	256	331	406	384	407	513	583	525	567	929
Imports																
All countries ^a	15,287	17,536	19,768	18,886	19,952	21,467	23,750	24,470	28,190	28,195	29,647	32,572	36,126	41,238	44,758	48,432
United States	707	933	1,114	1,252	1,480	1,636	1,713	1,746	1,935	2,016	2,067	2,373	2,836	3,347	3,664	4,058
Canada	389	432	484	525	543	494	266	929	675	651	740	821	1,002	1,146	1,218	1,281
Japan	1,204	1,430	1,578	1,506	1,586	1,655	1,995	2,154	2,588	2,427	2,252	2,320	2,541	2,856	3,029	3,225
Germany	1,522	1,00,1	,98,- 1,00,0	1,700	1,827	2,068	2,380	2,479	7,089 7,11	7,50	2,785	3,407	3,543	3,592	4,233	4,550
United Kingdom	657	,029 844	1,020	1,000	1,00,	1,170	1,200	1,536	1,71	1,930	1 743	1 978	2,774	3,140 2,762	5,459 0.950	3,720
Italy	755	904	1.129	1.068	1.177	1,357	1.604	1.657	2.096	2.116	2.330	2.418	2.795	2.886	2.654	2.951
China	19	88	52	29	86	121	175	284	421	307	398	528	531	554	296	681
South Korea	9/	88	114	132	155	149	152	163	213	213	236	289	304	329	396	457
Taiwan	118	144	165	167	194	202	223	237	245	236	244	267	328	366	407	437
Singapore	114	122	132	125	130	139	150	159	171	182	170	169	193	277	309	332
Hong Kong	225	261	258	254	267	304	348	426	475	451	204	631	678	646	730	276
Apparent consumption			!			:	!								!	
All countries ^a	102,098	110,902	116,917	121,920	128,271	132,446	141,045	150,322	159,607	162,822	167,508	174,009	179,908	183,424	195,517	205,037
Canada	1 555	1 213	1 907	2,400	0,430	25,110	20,130	3 173	3 337	42,030	307,44	46,030	3,520	3 976	4 158	775 7
Japan	20,618	27,673	24,652	26.086	26.587	27.430	29,269	31.926	33,309	34.259	34.068	34.047	34.239	34.601	36,702	38.145
Germany ^b	9,240	10,968	12,139	12,597	13,949	13,822	13,053	12,006	12,118	13,048	12,936	13,600	13,148	14,056	15,271	16,354
France	3,370	4,218	3,920	4,726	4,845	5,139	5,369	5,399	6,106	7,243	7,949	8,508	9,461	10,204	10,696	11,286
United Kingdom	4,772	4,888	5,593	5,769	6,343	6,626	7,065	7,720	8,217	8,185	8,237	8,431	9,267	9,391	10,206	10,908
Italy	4,492	4,005	3,511	3,287	3,425	3,292	3,568	3,802	3,205	3,154	3,864	3,736	3,794	3,117	2,901	3,058
China	472	735	888	1,516	1,517	1,228	1,756	2,610	4,234	3,745	3,262	3,6/4	3,529	3,454	3,798	4,284
Jaiwan	303	343	430	436	505	557	245 066	575	621	2, 130 539	560,2	584	668 668	2,030	773	2,031
Singapore	130	5 5	157	185	274	261	357	420	. 6	437	417	555	511	521	519	573
Hong Kong	165	191	183	157	197	208	226	251	248	237	264	321	319	321	369	387
00 3-1-1-1 40	1															

^aA total of 68 countries are included.

^bGerman data are for the former West Germany only.

[&]quot;High-tech industries include aircraft, office and computing machinery, communication equipment, and drugs and medicines.

SOURCE: WEFA/ICF Global Industry Service (Eddystone, PA: Spring 1997). See figures 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8, 6-9, and 6-10.

Appendix table 6-6. **U.S. trade in advanced technology products: 1990-96** (Millions of U.S. dollars)

Product category	1990	1991	1992	1993	1994	1995	1996
		U.S. €	exports				
Total	94,727.6	101,641.5	107,091.3	108,356.6	120,743.3	138,416.5	154,909.2
Biotechnology	661.2	706.0	745.8	892.7	1,029.2	1,055.5	1,197.4
Life science	4,860.3	5,492.5	5,826.0	6,133.7	6,821.3	8,571.5	9,255.6
Opto-electronics	524.0	627.9	604.0	701.7	926.3	1,164.6	1,418.6
Computers and telecommunications	31,375.0	30,726.3	32,569.2	34,198.8	39,859.3	47,890.5	52,780.1
Electronics	7,535.5	8,925.6	9,968.4	11,987.4	16,235.6	31,391.7	36,548.0
Flexible manufacturing	3,095.7	3,251.4	3,412.6	4,039.0	5,191.0	7,469.6	8,583.6
Advanced materials	6,403.0	6,226.1	7,153.6	8,404.2	10,406.2	4,519.5	1,693.6
Aerospace	36,972.7	41,904.5	42,445.5	37,348.1	34,955.4	30,983.1	38,088.7
Weapons	687.9	851.7	784.1	745.1	730.6	1,040.5	1,466.9
Nuclear technology	1,260.5	1,304.2	1,502.4	1,375.6	1,560.6	1,272.0	1,258.9
Software technology	1,351.8	1,625.2	2,079.7	2,530.2	3,027.9	3,057.9	2,617.7
		U.S. i	mports				
Total	59,381.2	63,252.1	71,871.5	81,233.1	98,116.5	124,787.0	130,361.6
Biotechnology	32.1	48.7	48.8	59.2	73.3	444.8	548.8
Life science	3,417.6	4,305.8	4,821.4	4,607.5	4,821.5	6,607.2	7,291.6
Opto-electronics	1,138.0	2,038.4	2,570.3	2,531.0	2,544.1	2,816.6	3,172.8
Computers and telecommunications	30,110.5	29,153.4	33,848.5	39,790.2	49,440.0	58,865.6	61,346.1
Electronics	10,955.3	12,391.7	14,205.3	17,824.2	25,507.3	38,232.6	36,756.8
Flexible manufacturing	1,676.6	1,789.7	1,684.5	2,222.2	2,899.7	4,947.5	5,740.7
Advanced materials	1,045.6	1,051.5	1,548.4	2,052.9	1,091.8	1,527.6	1,219.8
Aerospace	10,713.8	12,106.0	12,687.2	11,613.3	11,135.6	10,540.5	12,805.4
Weapons	129.9	167.8	156.9	164.7	143.9	205.0	265.5
Nuclear technology	4.5	3.0	5.2	7.9	22.7	39.8	626.1
Software technology	157.4	196.0	295.0	360.0	436.5	559.8	588.0
		U.S. trad	e balance				
Total	35,346.4	38,389.4	35,219.8	27,123.6	22,626.8	13,629.5	24,547.6
Biotechnology	629.1	657.3	697.0	833.5	956.0	610.7	648.6
Life science	1,442.8	1,186.7	1,004.6	1,526.2	1,999.7	1,964.3	1,964.1
Opto-electronics	-613.9	-1,410.5	-1,966.3	-1,829.3	-1,617.8	-1,652.0	-1,754.2
Computers and telecommunications	1,264.5	1,572.9	-1,279.3	-5,591.4	-9,580.7	-10,975.1	-8,566.0
Electronics	-3,419.9	-3,466.1	-4,236.9	-5,836.8	-9,271.7	-6,840.9	-208.8
Flexible manufacturing	1,419.1	1,461.7	1,728.1	1,816.8	2,291.3	2,522.1	2,842.9
Advanced materials	5,357.5	5,174.6	5,605.3	6,351.3	9,314.4	2,991.9	473.8
Aerospace	26,258.9	29,798.5	29,758.3	25,734.8	23,819.7	20,442.7	25,283.3
Weapons	558.0	683.9	627.2	580.4	586.7	835.6	1,201.4
Nuclear technology	1,256.0	1,301.1	1,497.2	1,367.7	1,537.9	1,232.2	632.9
Software technology	1,194.5	1,429.2	1,784.7	2,170.3	2,591.4	2,498.1	2,029.7

 $SOURCE: U.S.\ Bureau\ of\ the\ Census,\ Foreign\ Trade\ Division<<http://www.fedstats.gov>>,\ 1997.$

See figure 6-11.

Appendix table 6-7. U.S. receipts and payments of royalties and fees associated with affiliated and unaffiliated foreign residents: 1987-95 (Millions of U.S. dollars)

			For	eign residents
	Total	Ā	ffiliated	Unaffiliated
		Receipts		
1987	9,914		7,629	2,285
1988	11,802		9,156	2,646
1989	13,064	1	0,207	2,857
1990	16,634	1	3,251	3,384
1991	18,107	1	4,395	3,712
1992	19,715	1	5,718	3,997
1993	20,323	1	5,707	4,616
1994	22,274	1	7,422	4,849
1995	26,953	2	1,619	5,333
		Payments		
1987	1,844		1,296	547
1988	2,585		1,410	1,175
1989	2,602		1,778	824
1990	3,135		2,206	929
1991	4,076		2,996	1,080
1992	5,074		3,381	1,694
1993	4,765		3,364	1,401
1994	5,518		3,810	1,708
1995	6,312		5,148	1,163
		Balance		
1987	8,070		6,333	1,738
1988	9,217		7,746	1,471
1989	10,462		8,429	2,033
1990	13,499	1	1,045	2,455
1991	14,031	1	1,399	2,632
1992	14,641	1.	2,337	2,303
1993	15,558	1.	2,343	3,215
1994	16,756	1	3,612	3,141
1995	20,641	1	6,471	4,170

NOTE: Details may not add to totals because of rounding.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business, Vol. 76, No. 11 (November 1996).

See figure 6-12.

Appendix table 6-8.

U.S. receipts and payments of royalties and license fees generated from the exchange and use of industrial processes with unaffiliated foreign residents, by region/country: 1987-95 (Millions of U.S. dollars)

				E	Receipts	s					[Pay	Payments								Balance	e C			
Region/country	1987 1988		1989	1990	1991	1992	1993	1994	1995	1987	1988	1989 1	1990 1	1991 19	1992 19	1993 1	1994 1995	95 1987	37 1988	8 1989	1990	1991	1992	1993	1994	1995
All countries	1,678	1,962	2,051	2,333	2,434	2,525	2,820	3,043	3,316	459	525	612		8 962	118 1,1	1,054 1,0	,056 819	9 1,21	1,437	7 1,439	39 1,668	1,638	3 1,707	1,776	1,987	2,497
Canada	87	09	62	79	62	47	4	53	49	6	Ξ	∞	16	Ξ		80	=======================================	8			54 63		37	33	42	4
Europe	446	517	530	630	575	637	642	771	737	320	355	433	482 (637 6	635 8	820 7	734 482	2 126	26 162		97 148	-62		-178	37	255
European Union	353	410	378	200	475	498	496	601	652	248	279		360	426 4	417 4	-	420 401	1 105						24	181	251
France	73	85	52	78	91	64	83	129	89	33	37	51	54	73			104 109		40 45	10	1 24	. 18	64	က	25	4
Germany ^a	79	73	77	107	97	108	109	142	162	100	112	137		182		187	128 109				-60 -26			-78	14	53
Italy	22	73	89	105	70	66	69	7	28	25	20	22	59	34	24	6	9	7 32	32 53		92 91	36	75		65	51
United Kingdom	9	29	8	91	106	103	103	114	109	72	06	102					104 99							-20	유	14
All other	93	107	152	130	100	263	272	315	340	72	9/	91		211	_	409	392 16		21 3			٠	263	•	-77	178
So./Central America	64	48	54	29	82	73	Ω	84	69	2	*	*	*	-		□	٥				54 59		× ×		Ž	
Brazil	19	7	14	80	80	9	7	80	00	*	*	*	*	*	*	2									9	
Mexico	4	13	8	23	31	29	28	33	22	က	*	*	*	*	-	*			11						32	
All other	31	28	22	28	46	38	Ω	43	39	7	ΑĀ	Ϋ́	Ϋ́	-	۵	□									Ž	
Africa		22	24	22	34	27	36	26	7	*	4	*	0	*		*	-					34		36	25	
Middle East	Ω	18	17		25	21	33	21	38	2	က	4	က	4	2	6									12	
Asia & the Pacific	936	1,185	1,248	•	1,638	1,704	1,966	2,077	2,382	92	112	120		140 1	152 2		283 299	9 841	1,073	-	,128 1,305	_	1,552	Ť	1,794	2,083
Hong Kong	4	9	7	9	9	Ξ	12	80	51	-	*	*	0	*	*	7	3					9		9	2	Ϋ́
India	18	40	26	21	4	34	Ω	28	35	*	*	*	*	*	*	0	*					14		¥	28	35
Indonesia	2	2	∞	=	20	13	20	20	4	0	*	0	0	0	*			*			8 11		_	20	20	14
Japan	723	883	897	1,028 1,	1,219	1,268	1,434	1,373	1,501	88	108	109	141	138 1	145	191	262 280					1,081	1,123	1,243	1,111	1,221
Malaysia	*	*	2	7	2	7	18	19	Ω	0	0	0	0	0	0	*	0				2		7	. 18	19	Ϋ́
The Philippines	က	4	4	4	2	က	Ω	-	2	0	*	-	0	0	*	*	*	*			8	_	(r)	Ϋ́	_	2
Singapore	30	13	∞	19	21	20	20	73	32	*	0	0	0	*		*	*	ო *			8 19	21	20	20	73	32
South Korea	34	107	167	249	225	220	278	416	585	*	*	Ω	۵	*	-	_		3	34 107	•	N	225	219	277	410	Ϋ́
Taiwan	21	46	34	22	22	45	34	39	9	*	*	Ω	-	*	2	7	2	*			34 54			32	37	92
All other	86	81	92	70	72	98	Ω	100	Ω	9	4	10	□	2	□	4	10 NA		92 77			07	98 (Ϋ́	8	Ϋ́
All other	145	112	116	26	15	16	Ν	Ξ	20	28	40	47	7	28 1	¥	ΑĀ		_						Α	Ϋ́	Ϋ́

^{* =} less than \$500,000; D = withheld to avoid disclosing operations of individual companies; NA = not available

See figure 6-13.

NOTE: Industrial processes include patents and other proprietary inventions and technology.

^{*}German data prior to 1990 are for the former West Germany only. Beginning in 1990, these data are also for the former East Germany.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business, Vol. 76, No. 11 (November 1996): 90-93.

Science & Engineering Indicators – 1998

Appendix table 6-9. **R&D performance in the United States, by industry: 1973-94**(Millions of current purchasing power parity dollars)

Industry	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	9861		. 8861	1989	. 0661	1991	1992	663	1994
Total, all industries	21,250	22,887	24,206	26,997	ı		l	l	51,810	58,650	65,268 7	l	l	l		Ι'	102,055 10	109,727 11	116,952 1	119,110 1	117,400 1	119,595
Total manufacturing	20,535				28,867	32,075	36,686	42,690				69,895 7	77,525 8	80,377 8	84,311 8	86,502		88,934		30,177 8		96,307
Food, drink & tobacco	269	298	335	355													_			1,386	1,345	1,476
Textiles, footwear & leather	64	69	70	85	83	88	101	115	116	136	150	۵.				260	260	297			313	344
Wood, cork & furniture	7	84	88	107	123	126	139	148	161	159	152					173	197	245	210		259	269
Paper & printing	194	237	249	313	333	387	445	495	266	999	552			541	604		879	1,059	1,235	1,245	1,643	1,723
Chemicals	3,040	3,541	3,907	4,285	4,611	5,133	5,877	6,844	8,335	•	10,219 1	•	-	1,582	2,139 1	3,816	15,134		18,382		50,706	20,701
Industrial chemicals	1,418	1,643	1,766	1,925	2,085	2,272	2,521	2,859	3,540	4,112		4,608					6,261	_	7,587		8,248	7,557
Pharmaceuticals	869	807	981	1,091	1,117	1,308	1,517	1,777	2,085		2,913						5,808	6,287	7,061	7,944	9,146	9,633
Petroleum refining	498	622	693	767	918	1,060	1,262	1,552	1,936				2,220	2,018	1,897		2,180	2,306	2,498	2,277	2,152	1,950
Rubber & plastics products	426	469	467	502	491	493	277	929	775					721	209	752	885	1,153	1,236	1,323	1,161	1,561
Stone, clay & glass	199	217	233	263	287	324	356	406	460	513	624	733		950	962	738	637	616	483	510	538	591
Basic metal industries	308	358	443	909	538	260	634	728	878	286	1,085	717	740	803	730	637	989	739	714	522	699	069
Ferrous metals	163	181	215	256	284	314	375	443	555	613	637	381	324	345	252	253	251	238	228	224	289	247
Nonferrous metals	145	177	228	250	254	246	259	285	323	374	448	336	416	458	478	384	435	501	486	298	380	443
Fabricated metal products																						
and machinery	16,232	17,138	17,941	20,023	22,234	24,718	28,318	32,970	38,306	43,003 4	47,780 5	55,040 6	62,076	64,443 6		68,440 (68,507	67,201 6	65,297	36,351 (34,628	39,645
Fabricated metal products	291	313	324	358	386	384	455	220	624	625	701	842	829	895	783	881	904	939	974	1,017	1,158	1,11
Nonelectrical machinery	816	882	926	1,085	1,225	1,400	1,611	1,939	2,417	2,411	2,392	2,404	2,394	2,396	2,428	2,682	2,729	2,753	3,555	3,534	3,431	4,004
Office machinery &																						
computers	1,733	2,103	2,220	2,402	2,655	2,883	3,214	3,962	4,401	2,667	6,635	8,100	9,822	9,794	9,347 1	10,444	11,705	11,693 1	11,220	11,404	9,313	9,664
Electrical machinery	1,834	2,047	2,121	2,382	2,295	2,476	2,775	3,048	3,476	2,858	2,815	1,848	1,277	_		1,419	2,126	3,444	3,091	2,722	2,537	2,664
Electronic equipment																						
& components	3,068	2,964	2,984	3,254	3,591	4,031	5,049	6,127	6,853	8,065	9,866 1	11,930 1	13,155 1	13,730 1	14,609 1	12,709	11,192	9,956 1	10,324	10,638	10,812	12,674
Shipbuilding	1	1	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Motor vehicles	2,405	2,389	2,340	2,778	3,358	3,879	4,509	4,955	4,806	4,797	5,318	6,057	6,984	9,732	9,279 1	10,085 1	11,020 1	10,256 1	10,388	9,924	11,793	13,406
Aerospace	5,052	5,278	5,713	6,339	7,033	7,536	8,041		11,968	14,451 1	15,406 1	18,858 2		_		24,168 2		20,635 1	16,629	. 851,71	15,056	14,260
Transport equipment	72	87	06	94	120	131	159	162	147	199	381	333	371		209	522	208	_	411	412	409	421
Instruments	961	1,075	1,173	1,331	1,571	1,998	2,505	3,029	3,614	3,930	4,266	4,602	5,013		5,222	5,530	5,992	7,055	8,705	9,542	10,119	11,441
Other manufacturing	158	177	205	217	243	266	288	364	444	519	541	379	361	382	383	420	449	613	624	099	831	898
Total services	715	768	735	845	928	1,229	1,540	1,815	1,906	2,472	3,337	4,905	6,714	7,446	7,844 1	0,513 1	14,031	20,793 2	28,446	28,933	26,468	23,288

SOURCE: Organisation for Economic Co-operation and Development, Analytical Business Enterprise R&D Database (Paris: April 1997).

See figure 6-15.

Appendix table 6-10. **R&D performance in Japan, by industry: 1973-94**(Millions of current purchasing power parity dollars)

Industry	1973	1974	1975	1976	1977	1978	1979 1	1980 1	1981 1	1982 1	1983 19	1984 19	1985 19	1986 19	1987 1988	1989	1990	0 1991		1992 1993	-	994
Total, all industries Total manufacturing	5,052 4,792	5,559	6,037 5,692	6,643 6,289	7,445	8,322 10 7,889 9	10,249 12 9,725 11	12,536 15 11,906 14	15,257 17 14,580 16	17,703 20, 16,978 19,	20,411 23, 19,545 22,	23,284 27, 22,296 26,	27,283 28,3 26,282 27,3	28,313 30,945 27,278 29,862	35,483 362 34,176	4 κ		5	104 51,203 118 49,016	203 49,123 316 46,892		49,590 47,373
Food, drink & tobacco	137	135	165														1,205					1,291
Textiles, footwear & leather	85	73	8	74					271	227	228		287	290		358 409			474 (424
Wood, cork & furniture	12	15	22	56								09			3 22							177
Paper & printing	66	63	69	62																_		405
Chemicals	1,135	1,299	1,419		1,702						4								Ξ	_		365
Industrial chemicals	674	787	813				1,203 1	1,470 1			2,169 2,	2,527 2,			3,408 3,804	04 4,314	14 4,612				5,058 5,0	058
Pharmaceuticals	250	277	341	387	425	489						_						43 3,047				494
Petroleum refiningRubber & plastics	20	24	61	64	92							_										438
products	161	181	204	210	244	273	306	359									39 1,1	75 1,3				375
Stone, clay & glass	108	133	150	184	186	212	280	332														600
Basic metal industries	310	375	413	453	475	517	614	908	998 1	1,117 1,	1,164 1,	1,268 1,	1,566 1,	1,691	1,666 1,819	19 1,987	37 2,275		2,628 2,4	2,452 2,3	2,358 2,0	2,085
Ferrous metals	231	281	320	352	366	392	461	287			~			•								313
Nonferrous metals	78	94	93	101	109	125	152	219	284													773
Fabricated metal products																						
and machineryFabricated metal	2,858	3,134	3,307	3,724	4,214	4,822	5,919 7	7,128 9	9,086 10	10,723 12,	12,504 14,	14,384 17,	17,176 17,	17,578 19,140	140 22,197	97 26,220	20 30,715	15 32,008	08 32,167	167 30,426		31,144
products	80	8	105	143	136	145	210	208														617
Nonelectrical machinery	466	647	683	663	843	764	936 1	1,174 1	1,389 1	,596 1,	,772 1,	,997 2,	,300 2,	,341 2,5	,536 2,779	79 3,389	39 4,104	4	,334 4,	,265 4,3	,349 4,0	,615
Office machinery &	7	5	1	5	Ċ	Ċ	Ċ				•	٦		C				•				Š
computers	- [0 [90 L	137	192	857	7 000		,	7000	2 2	901	, , , , ,	,580	2,7	,224 2,902	4,067	4,384	4 ι	7,4	_	4,430 4,7	4,734
Electrical machinery Electronic equipment	0/9	228	/60	1.28	808	0/6	L 881,1	L 221,1			.N	N	. •		3,172 3,64			O		2,'G 181,'C		190
& components	756	865	818	686	922	1,082	1,357 1	1,980 2			•				5,585 6,311			_		•	,690 8,	190
Shipbuilding	44	46	45	41	35	30																87
Motor vehicles	290	631	685	761	926	1,177	•	1,601 2	2,102 2	2,374 2,			3,494 3,	3,697 3,7	3,774 4,52	23 5,389	39 6,547		6,527 6,	6,785 5,7		519
Aerospace	26	62	74	27	29	73				_											381	316
Transport equipment	28	12	14	56	36	46		72		_										95		104
Instruments	120	121	129	153	202	251	297	396	533							•			•	•		842
Other manufacturing	53	29	29	69	80	88	92	138	142	161	167	201	212	244 2	260 279	79 312		356 4	_			473
Total services	225	220	294	299	373	373	464	226	602							'		-	,648 1,	,993 2,0	,034 2,0	045

SOURCE: Organisation for Economic Co-operation and Development, Analytical Business Enterprise R&D Database (Paris: April 1997).

Science & Engineering Indicators – 1998

See figure 6-15.

Science & Engineering Indicators – 1998

Appendix table 6-11. **R&D performance in the European Union, by industry: 1973-94**(Millions of current purchasing power parity dollars)

																						1
Industry	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982 1	1983 1	1984 1	1985 1	1986 19	1987 19	1988 19	1989 1990	1991		1992 1993	3 1994	94
Total, all industries	12,282	13,777	15,467 17,134		32	21,543 2	25,759 28	28,828 32		36,067 38		42,036 47	47,819 51	51,872 55,	55,935 60,		66,263 71,186			78,669 76,804		77,813
Total manufacturing	11,201		14,047 15,551	15,551										,241 49,	24						_	486
Food, drink & tobacco	247	297	328	363				574	594	632				887								1,413
Textiles, footwear & leather	133	161	161	158				167	169	178				245								447
Wood, cork & furniture	14	16	16	17				61	64	9/	82			121		122	129 1					184
Paper & printing	85	88	92	101					188	206	221	245		281								422
Chemicals	2,824	3,232	3,707	4,149	4,554	5,071						_	0,724 11	_	2,698 14,	4,138 15,	_	-	6,783 17,8	389 17,596	_	299
Industrial chemicals	1,641	1,913	2,205	2,476	2,689	2,869		_	-	•	٠.					7,563 8,			8,284 8,			660
Pharmaceuticals	753	855	066	1,121	1,248	1,521	1,801	•	2,205	2,526 2	2,788 3	3,003	3,353 3	3,638 4,	4,341 5,		5,674 6,4		- +	7,565 7,683		7,819
Petroleum refining	223	241	267	291	300	318	354									699			821			945
Rubber & plastics																						
products	208	224	244	261	316	363	454	530	610	672	229	718	791									104
Stone, clay & glass	156	177	182	193	210	250	302	332	329	392	424	444	479								_	391
Basic metal industries	312	395	433	454	467	909	286	650	733	266	846	867	918		_		•	1,080 1,	,106 1,		_	680
Ferrous metals	223	262	297	305	309	334	404	441	504	547	581	592	637	619	634	692	713 7			811 7	738	787
Nonferrous metals	88	133	135	149	159	172	182	208	229	252	265	275	281					363	336			302
Fabricated metal products																						
and machinery	7,377	8,209	9,061	9,061 10,021 10,998		12,937 1	15,732 1	17,899 20	20,259 22	22,356 23	23,900 26	26,525 30	30,320 31	31,787 34,	34,076 36,	36,738 39,	39,993 43,150	50 44,547		46,184 44,616		45,358
Fabricated metal																						
products	117	139	164	189	222	305		490	574	889	754	802	006	928	957 1,			1,231 1,		1,128 1,1	1,125 1,7	1,184
Nonelectrical machinery	820	893	986	1,065	1,201	1,521	1,952		2,412	2,690 2	,846 3	,000	,402 3			4,362 5,	5,000 5,0		5,267 5,			899
Office machinery &																						
computers	374	415	481	296	731	816	932	1,004	1,166	1,326 1	1,460 1	1,755 2	2,074 2	2,107 2,	2,302 2,	2,604 2,	2,851 2,9	2,980 3,1	3,118 3,0	3,036 2,761		2,470
Electrical machinery	993	1,159	1,282	1,400	1,462	1,650																251
Electronic equipment																						
& components	1,796	2,077	2,378	2,637	2,934	3,649	4,520								٠.	10,317 11,	•	11,888 11,294	٠.	11,719 11,446	•	296
Shipbuilding	86	88	88	92	92	8																239
Motor vehicles	1,263	1,361	1,489	1,667	1,901	2,211	2,673				•							8,592 9,3		•	•	425
Aerospace	1,695	1,825	1,920	2,074	2,117	2,303					•											358
Transport equipment	24	28	59	4	63	62		75	06	108	132	153	155	161	171	175	167		322	294 312		339
Instruments	209	224	242	258	273	327	397											980 1,0				225
Other manufacturing	26	28	64	94	117	129					122	114										216
Total services	749	868	1,003	1,128	1,300	1,387	1,518	. 819,1	1,849	2,093 2	,289 2	2,454 2	,853 4	,634 4,	,948 5,	,614 6,	9	,626 7,1	∞	,613 9,1		121
																						I

NOTE: The member countries of the European Union are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. SOURCE: Organisation for Economic Co-operation and Development, Analytical Business Enterprise R&D Database (Paris: April 1997).

See figure 6-15.

Appendix table 6-12. Number of U.S. patents granted, by inventor residence, inventor sector, and year of grant: 1963-95

Inventor residence/sector	Total 1963-95	1963-82	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
TOTAL	2,401,282	1,234,646	57,888	56,860	67,200	71,661	70,860	82,952	77,924	95,537	90,364	96,513	97,441	98,342	101,675	101,419
Inventor residence	1 407 060	200 390	900 66	90 074	790 00	200 555	20 106	70 500	70,406	404	7 207	100	60.060	100 001	20.02	720
Foreign origin	903,313	369,549	23,992	23,989	28,833	32,106	32,734	39,432	37,428	45,352	42,977	45,331	45,189	45,111	45,610	45,680
Argentina	698	417	18	21	500	- 2	17	8 6	16	502	17	16	50	24	32	31
Austria	8,010 8,653	4,083	000	267	256	318	357	345	337	000	393	359	370	373	280	9.55 8.55 8.55 8.55
Belgium	8.626	4,459	224	202	240	240	243	295	305	329	313	324	324	320	351	397
Brazil	874	330	27	19	20	30	27	34	59	36	4	61	40	22	09	63
Bulgaria	465	246	13	19	22	21	21	32	23	16	27	10	2	2	4	-
Canada	43,063	20,252	066	1,000	1,206	1,342	1,314	1,594	1,489	1,959	1,862	2,035	1,964	1,944	2,008	2,104
China	245	107 1 637	O 6	- «	7 6	- 5	ა გ	8 4	4 ⁄ 33	3 25	4 ⁴	25.	41 17	3 £	φ ξ	29 t
Denmark	5,036	2,521	121	125	150	187	182	204	151	221	158	210	193	197	207	199
Finland	4,843	1,330	125	116	167	200	210	275	232	230	304	331	360	293	312	358
France	72,156	35,247	1,975	1,895	2,162	2,400	2,369	2,874	2,661	3,140	2,866	3,030	3,029	2,908	2,779	2,821
Germany	188,830	91,571	5,467	5,477	6,323	6,718	6,856	7,885	7,353	8,353	7,612	7,680	7,310	6,893	6,732	6,600
Hundary	2.242 2.242	243 901	- 1	106	111	6 2 6	٠ <u>٢</u>	127	4 6	6 C	2 6	32 50	8 8	90	5. 46.	20 8
India	492	231	4	4	12	9	8	12	4	4	23	52	24	300	27	37
Ireland	862	268	24	18	59	30	58	38	43	65	24	22	22	53	20	52
Israel	4,866	1,317	114	109	162	179	189	245	538	326	533	302	335	314	320	384
Italy	26,920	11,960	/ 52 8 149	629 8 793	11 110	919	13 200	16.557	16.158	1,297 20.168	19 525	21,209	1,2/1	1,286	02,15	1,078
Liechtenstein	473	274	19	12	16	13.	16	16,79	10,2	17	15	1, 1	16	11	16	17
Luxembourg	292	198	56	27	24	37	31	22	59	59	17	27	26	28	22	24
Mexico	1,614	1,076	35	32	42	32	37	49	44	33	32	28	39	45	4 5	40
Netherlands	22,609	11,104	619	626	726	992	722	922	808 7	1,060	929	992	854	80.1	823	799
New Zealand	70L,1 088.0	452	44 65	88 99	20 84	S 6	22.8	68 135	52	28 126	55 112	- 1 1	4 6	117	126	130
Poland	626	451	26 26	20	15	3 =	2 4	5 5	- 80	5 4	17	- œ	2	<u> </u>	2 00	<u>8</u> ∞
South Africa	2,615	1,238	73	09	82	96	88	107	103	134	115	105	26	93	101	123
South Korea	4,649	102	4 :	26	30	41	46	84	26	159	225	404	538	779	943	1,161
Spain	2,798	1,219	49	20	69	78/	97	115	126	131	130	153	133	159	141	148
Switzerland	38.553	21,623	1.147	1.017	1174	1 233	1212	373	1.245	1363	1 284	1.335	1196	1126	1 169	1.056
Taiwan	9,229	316	8	92	66	174	208	343	457	591	732	906	1,000	1,189	1,443	1,620
United Kingdom	85,837	51,143	2,132	1,930	2,269	2,494	2,405	2,775	2,579	3,094	2,789	2,799	2,425	2,294	2,234	2,475
U.S.S.R.	6,963	5,129	508	222	214	147	116	5 5	9 6	161	174	178	99 6	8 5	3 23	2 5
Others (113 countries)	4,14	2,142	73 -	71	- 68	10	- 06	107	102	153	119	143	151	166	254 254	289
Inventor sector																
U.S. corporation	1,145,904	654,518	25,783	25,677	29,999	31,181	29,490	33,726	31,437	38,664	36,093	39,133	40,307	41,826	44,035	44,035
U.S. individual	365,564	23,023	8,553	7,574	8,911	9,265	9,477	10,887	10,122	13,028	983 12,542	13,207	12,751	12,281	12,805	12,885
Foreign corporation	711,249	269,314	18,856	19,246	23,238	25,957	26,545	32,371	30,960	37,506	35,548	37,594	38,237	38,401	38,788	38,688
Foreign government	9,638	3,748 66.167	3.322	339 2.976	3.379	3.636	3.847	555 4.432	453 4.219	5.018	423	4.924	463	434	290 4.493	4.538
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SOURCE: U.S. Patent and Trademark Office, Patenting Trends in the United States, 1963-95 (Washington, DC: 1996).

See figures 6-16, 6-17, and 6-18.

Appendix table 6-13. Patent classes most emphasized by inventors from the United States patenting in the United States: 1985 and 1995

		Paten	ts granted t	o inventor	s from:		
		All co	untries	United	States	Activit	y index
Paten	t class number and title	1985	1995	1985	1995	1985	1995
166	Wells	336	338	306	285	1.783	1.667
606	Surgery	154	602	103	484	1.310	1.590
604	Surgery	298	843	232	674	1.524	1.581
607	Surgery: light, thermal, and electrical application	94	293	71	211	1.479	1.424
585	Chemistry of hydrocarbon compounds	225	223	168	158	1.462	1.401
206	Special receptacle or package	262	404	183	280	1.368	1.370
128	Surgery	290	846	164	582	1.107	1.360
220	Receptacles	182	230	101	155	1.087	1.332
248	Supports	211	247	135	166	1.253	1.329
380	Cryptography	47	204	34	137	1.416	1.328
052	Static structures (e.g., buildings)	313	315	201	207	1.257	1.299
426	Food or edible material: processes, compositions, and products	438	479	287	309	1.283	1.275
273	Amusement devices: games	108	331	65	213	1.178	1.272
134	Cleaning and liquid contact with solids	84	224	58	144	1.352	1.271
436	Chemistry: analytical and immunological testing	126	280	90	180	1.399	1.271
326	Electronic digital logic circuitry	115	333	67	211	1.141	1.253
435	Chemistry: molecular biology and microbiology	385	1,346	229	852	1.165	1.252
530	Chemistry: natural resins or derivatives; peptides	134	271	85	171	1.242	1.248
342	Communications: directive radio wave systems and devices	109	274	57	172	1.024	1.241
395	Information processing system organization	550	3,025	355	1,874	1.264	1.225
062	Refrigeration	423	515	240	315	1.111	1.209
210	Liquid purification or separation	452	782	254	478	1.100	1.209
239	Fluid sprinkling, spraying, and diffusing	230	240	132	146	1.124	1.203
424	Drug, bio-affecting and body treating compositions	404	1,166	221	705	1.071	1.195
015	Brushing, scrubbing, and general cleaning	135	229	84	138	1.218	1.192
362	Illumination	171	330	109	199	1.248	1.192
379	Telephonic communications	244	733	147	438	1.180	1.181
297	Chairs and seats	154	223	69	132	0.877	1.170
361	Electricity: electrical systems and devices	463	763	269	450	1.138	1.166
200	Electricity: circuit makers and breakers	273	207	159	122	1.140	1.165
340	Communications: electrical	381	598	184	351	0.946	1.161
137	Fluid handling	531	427	324	250	1.195	1.158
235	Registers	106	321	46	187	0.850	1.152
029	Metal working	604	699	365	404	1.183	1.143
536	Organic compounds—part of the class 532–570 series	95	320	39	183	0.804	1.131
174	Electricity: conductors and insulators	201	349	120	199	1.169	1.127
280	Land vehicles	285	581	93	331	0.639	1.126
439	Electrical connectors	496	810	349	459	1.378	1.120
073	Measuring and testing	938	1,100	526	619	1.098	1.113
053	Package making	289	351	138	197	0.935	1.110
324	Electricity: measuring and testing	409	893	237	501	1.135	1.109
315	Electric lamp and discharge devices: systems	236	332	145	185	1.203	1.102
162	Paper making and fiber liberation	163	208	75	115	0.901	1.093
502	Catalyst, solid sorbent, or support therefor: product	425	302	279	167	1.285	1.093
341	Coded data generation or conversion	170	280	84	152	0.968	1.073
330	Amplifiers	247	241	119	130	0.943	1.067
427	Coating processes	555	691	298	370	1.051	1.059
385	Optical waveguides	178	504	100	269	1.100	1.055
568	Organic compounds—part of the class 532–570 series	365	302	221	160	1.186	1.048
156	Adhesive bonding and miscellaneous chemical manufacture	546	779	327	412	1.173	1.046
414	Material or article handling	316	324	170	171	1.053	1.044
	Tractorial of altitole flating		<u> </u>				

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in

Appendix table 6-14.

Patent classes most emphasized by inventors from Japan patenting in the United States: 1985 and 1995

		Paten	ts granted t	to inventor	s from:		
		All co	untries	Jap	oan	Activity	/ index
Pater	t class number and title	1985	1995	1985	1995	1985	1995
369	Dynamic information storage or retrieval	277	658	158	508	2.671	3.003
354	Photography	355	471	245	332	3.232	2.742
084	Music	101	220	63	151	2.921	2.670
355	Photocopying		753	213	489	2.364	2.526
358	Facsimile or television recording		629	169	395	3.191	2.443
400	Typewriting machines		206	86	118	1.900	2.228
365	Static information storage and retrieval		897	95	489	1.951	2.121
360	Dynamic magnetic information storage or retrieval		789	271	411	2.666	2.026
257	Active solid-state devices (e.g., transistors, solid-state diodes)	294	1,308	107	675	1.704	2.008
430	Radiation imagery chemistry: process, composition, or products		1,421	392	732	2.464	2.004
347	Incremental printing of symbolic information		486	184	247	2.693	1.977
359	Optics: systems (including communication) and element		1083	198	521	1.689	1.871
310	Electrical generator or motor structure		386	104	175	1.586	1.764
348	Television		1028	179	461	1.473	1.744
148	Metal treatment		352	68	156	1.415	1.724
345	Selective visual display systems		356	48	146	1.414	1.595
271	Sheet feeding or delivering		247	54	101	1.453	1.591
372	Coherent light generators		364	27	140	0.996	1.496
118	Coating apparatus		288	53	107	1.193	1.445
382	Image analysis		323	43	120	1.678	1.445
242	Winding, tensioning, or guiding		310	118	113	1.506	1.418
318	Electricity: motive power systems		371	120	134	1.557	1.405
123	Internal-combustion engines		727	558	260	2.369	1.391
333	Wave transmission lines and networks		213	29	75	0.813	1.370
364	Electrical computers and data processing systems		1,529	221	512	1.489	1.303
428	Stock material or miscellaneous articles		1,890	382	630	1.397	1.297
371	Error detection/correction and fault detection/recovery	-	431	28	141	0.923	1.273
425	Plastic article or earthenware shaping or treating		290	33	92	0.588	1.234
437	Semiconductor device manufacturing: process		1362	106	431	1.306	1.231
363	Electric power conversion systems		206	28	65	1.009	1.227
501	Compositions: ceramic		215	47	67	1.550	1.212
313			282	50	87	1.059	1.200
303	Electric lamp and discharge devices		202	24	62	1.441	1.194
327	Fluid-pressure and analogous brake systems		627	88	192	1.364	1.194
356			669	79	200	1.088	1.163
455	Optics: measuring and testing		403	40	120		
	Telecommunications					1.185	1.158
523 429	Synthetic resins or natural rubbers—part of the class 520 series	277	210	58	62	0.980	1.149
429	Chemistry: electrical current producing apparatus,	221	207	47	444	0.006	1 1 1 6
050	product and process		387		114	0.996	1.146
250	Radiant energy		993	149	287	1.297	1.124
395	Information processing system organization		3,025	131	871	1.115	1.120
341	Coded data generation or conversion		280	52	79	1.432	1.098
381	Electrical audio signal processing systems and devices		217	46	61	1.528	1.094
526	Synthetic resins or natural rubbers—part of the class 520 series		363	80	101	1.319	1.082
074	Machine element or mechanism		290	121	80	1.552	1.073
417	Pumps		237	64	65	0.979	1.067
525	Synthetic resins or natural rubbers—part of the class 520 series		726	132	199	1.122	1.066
439	Electrical connectors		810	38	219	0.359	1.052
060	Power plants		547	85	147	1.047	1.045
101	Printing		269	29	72	0.689	1.041
524	Synthetic resins or natural rubbers—part of the class 520 series		725	98	194	0.691	1.041
219	Electric heating	627	527	191	139	1.426	1.026

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in 1995.

Appendix table 6-15.

Patent classes most emphasized by inventors from Germany patenting in the United States: 1985 and 1995

		Paten	ts granted	to inventors	s from:		
		All co	untries	Gerr	many	Activit	y index
Pater	t class number and title	1985	1995	1985	1995	1985	1995
303	Fluid-pressure and analogous brake systems	78	202	21	68	2.577	4.576
101	Printing	197	269	52	90	2.526	4.548
188	Brakes	182	223	23	61	1.210	3.719
198	Conveyors: power-driven	233	271	27	51	1.109	2.558
548	Organic compounds - part of the class 532-570 series	212	281	41	52	1.851	2.516
072	Metal deforming	299	235	34	41	1.088	2.372
546	Organic compounds—part of the class 532–570 series	209	232	23	40	1.053	2.344
123	Internal-combustion engines	1,103	727	167	123	1.449	2.300
271	Sheet feeding or delivering	174	247	22	38	1.210	2.091
378	X-ray or gamma ray systems or devices	122	234	27	35	2.118	2.033
425	Plastic article or earthenware shaping or treating	263	290	42	43	1.528	2.016
568	Organic compounds—part of the class 532-570 series	365	302	44	43	1.154	1.936
549	Organic compounds—part of the class 532-570 series	214	235	31	33	1.386	1.909
074	Machine element or mechanism	365	290	40	40	1.049	1.875
528	Synthetic resins or natural rubbers—part of the class 520 series	411	531	58	69	1.351	1.767
524	Synthetic resins or natural rubbers—part of the class 520 series	664	725	85	94	1.225	1.763
451	Abrading	195	209	25	27	1.227	1.756
242	Winding, tensioning, or guiding	367	310	60	40	1.565	1.754
423	Chemistry of inorganic compounds	590	390	85	49	1.379	1.708
525	Synthetic resins or natural rubbers—part of the class 520 series	551	726	51	87	0.886	1.629
252	Compositions	785	1,039	73	119	0.890	1.557
248	Supports	211	247	23	28	1.043	1.541
204	Chemistry: electrical and wave energy	326	426	21	45	0.617	1.436
417	Pumps	306	237	43	25	1.345	1.434
073	Measuring and testing	938	1,100	109	115	1.112	1.421
422	Chemical apparatus and process disinfecting,		.,				
	deodorizing, preserving, or sterilizing	211	526	27	55	1.225	1.421
106	Compositions: coating or plastic	207	393	36	41	1.664	1.418
297	Chairs and seats	154	223	27	23	1.678	1.402
222	Dispensing	249	339	21	34	0.807	1.363
239	Fluid sprinkling, spraying, and diffusing	230	240	23	24	0.957	1.359
075	Specialized metallurgical processes, compositions for	190	212	21	21	1.058	1.347
414	Material or article handling	316	324	32	32	0.969	1.343
205	Electrolysis: processes, compositions used therein	301	266	31	26	0.986	1.329
526	Synthetic resins or natural rubbers—part of the class 520 series	284	363	19	35	0.640	1.311
342	· ·	109	274	12	26	1.054	1.290
053	Communications: directive radio wave systems and devices	289	351	31	32	1.034	1.239
523	Package making	277	210	30	19	1.027	1.239
	Synthetic resins or natural rubbers—part of the class 520 series				209	1.199	1.204
514 501	Drug, bio-affecting and body treating compositions Compositions: ceramic		2,360	196 13		0.876	
			215		19		1.201
363	Electric power conversion systems	130	206	8	18	0.589	1.188
162	Paper making and fiber liberation	163	208	16	18	0.939	1.176
502	Catalyst, solid sorbent, or support therefor: product	425	302	20	26	0.450	1.170
310	Electrical generator or motor structure	307	386	36	33	1.122	1.162
210	Liquid purification or separation	452 531	782	43	66 36	0.911	1.147
137	Fluid handling	531	427	56	36	1.009	1.146
060	Power plants	380	547	44	46	1.108	1.143
118	Coating apparatus	208	288	26	24	1.196	1.133
015	Brushing, scrubbing, and general cleaning	135	229	21	19	1.489	1.128
280	Land vehicles	285	581	32	48	1.075	1.123
427	Coating processes	555	691	62	57	1.069	1.121
219	Electric heating	627	527	45	43	0.687	1.109
536	Organic compounds—part of the class 532–570 series	95	320	15	26	1.511	1.105

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in 1995.

Appendix table 6-16.

Patent classes most emphasized by inventors from Taiwan patenting in the United States: 1985 and 1995

		Paten	ts granted t	o inventors	s from:		
		All co	untries	Tai	wan	Activity	y index
Paten	t class number and title	1985	1995	1985	1995	1985	1995
437	Semiconductor device manufacturing: process	380	1,362	0	152	0.000	15.159
345	Selective visual display systems	159	356	0	10	0.000	3.816
074	Machine element or mechanism	365	290	0	8	0.000	3.747
297	Chairs and seats	154	223	0	6	0.000	3.655
313	Electric lamp and discharge devices	221	282	0	6	0.000	2.890
257	Active solid-state devices (e.g., transistors, solid-state diodes)	294	1,308	0	27	0.000	2.804
327	Miscellaneous active electrical nonlinear devices	302	627	0	12	0.000	2.600
362	Illumination	171	330	0	6	0.000	2.470
425	Plastic article or earthenware shaping or treating	263	290	0	5	0.000	2.342
248	Supports	211	247	0	4	0.000	2.200
200	Electricity: circuit makers and breakers	273	207	0	3	0.000	1.969
333	Wave transmission lines and networks	167	213	0	3	0.000	1.913
280	Land vehicles	285	581	0	8	0.000	1.870
084	Music	101	220	0	3	0.000	1.852
365	Static information storage and retrieval	228	897	0	12	0.000	1.817
375	S Company of the comp	177	573	0	7	0.000	1.659
385	Pulse or digital communications	177	504	0	6		1.617
	Optical waveguides			0		0.000	
439	Electrical connectors	496	810		9	0.000	1.509
156	Adhesive bonding and miscellaneous chemical manufacture	546	779	0	8	0.000	1.395
264	Plastic and nonmetallic article shaping or treating: process	493	693	0	7	0.000	1.372
568	Organic compounds—part of the class 532–570 series	365	302	0	3	0.000	1.349
206	Special receptacle or package	262	404	0	4	0.000	1.345
400	Typewriting machines	212	206	0	2	0.000	1.319
075	Specialized metallurgical processes, compositions for	190	212	0	2	0.000	1.281
501	Compositions: ceramic	142	215	0	2	0.000	1.264
382	Image analysis	120	323	0	3	0.000	1.262
273	Amusement devices: games	108	331	0	3	0.000	1.231
188	Brakes	182	223	0	2	0.000	1.218
015	Brushing, scrubbing, and general cleaning	135	229	0	2	0.000	1.186
427	Coating processes	555	691	0	6	0.000	1.179
072	Metal deforming	299	235	0	2	0.000	1.156
330	Amplifiers	247	241	0	2	0.000	1.127
372	Coherent light generators	127	364	0	3	0.000	1.120
271	Sheet feeding or delivering	174	247	0	2	0.000	1.100
429	Chemistry: electrical current producing apparatus,						
	product, and process	221	387	0	3	0.000	1.053
423	Chemistry of inorganic compounds	590	390	1	3	6.917	1.045
205	Electrolysis: processes, compositions used therein	301	266	0	2	0.000	1.021
364	Electrical computers and data processing systems	695	1,529	0	11	0.000	0.977
029	Metal working	604	699	0	5	0.000	0.972
341	Coded data generation or conversion	170	280	0	2	0.000	0.970
204	Chemistry: electrical and wave energy	326	426	0	3	0.000	0.957
371	Error detection/correction and fault detection/recovery	142	431	0	3	0.000	0.945
524	Synthetic resins or natural rubbers—part of the class 520 series	664	725	0	5	0.000	0.937
359	Optics: systems (including communication) and element	549	1,083	0	7	0.000	0.878
052	Static structures (e.g., buildings)	313	315	0	2	0.000	0.862
	· • · · · · · · · · · · · · · · · · · ·			0	5		
370 326	Multiplex communications	276 115	800 333		2	0.000	0.849
	Electronic digital logic circuitry			0		0.000	0.816
053	Package making	289	351 507	0	2	0.000	0.774
219	Electric heating	627	527	0	3	0.000	0.773
148	Metal treatment	225	352	0	2	0.000	0.772
528	Synthetic resins or natural rubbers—part of the class 520 series	411	531	0	3	0.000	0.767
	The pativity index is the negrounted of the netents in a close that are grounted to						

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in 1995.

Appendix table 6-17.

Patent classes most emphasized by inventors from South Korea patenting in the United States: 1985 and 1995

		Patents granted to inventors from:						
			All countries		South Korea		Activity index	
Patent class number and title		1985	1995	1985	1995	1985	1995	
313	Electric lamp and discharge devices	221	282	0	27	0.000	7.550	
437	Semiconductor device manufacturing: process	380	1,362	0	123	0.000	7.122	
348	Television	569	1,028	0	85	0.000	6.520	
358	Facsimile or television recording	248	629	0	42	0.000	5.266	
369	Dynamic information storage or retrieval	277	658	0	39	0.000	4.674	
360	Dynamic magnetic information storage or retrieval	476	789	0	46	0.000	4.598	
365	Static information storage and retrieval	228	897	0	44	0.000	3.868	
242	Winding, tensioning, or guiding	367	310	0	13	0.000	3.307	
219	Electric heating	627	527	0	22	0.000	3.292	
371	Error detection/correction and fault detection/recovery	142	431	0	16	0.000	2.927	
315	Electric lamp and discharge devices: systems	236	332	0	12	0.000	2.850	
318	Electricity: motive power systems	361	371	0	13	0.000	2.763	
381	Electrical audio signal processing systems and devices	141	217	0	7	0.000	2.544	
257	Active solid-state devices (e.g., transistors, solid-state diodes)	294	1,308	0	38	0.000	2.291	
341	Coded data generation or conversion	170	280	0	8	0.000	2.253	
015	Brushing, scrubbing, and general cleaning	135	229	0	6	0.000	2.066	
062	Refrigeration	423	515	0	13	0.000	1.991	
340	Communications: electrical	381	598	0	15	0.000	1.978	
327	Miscellaneous active electrical nonlinear devices	302	627	0	15	0.000	1.887	
501	Compositions: ceramic	142	215	0	5	0.000	1.834	
326	Electronic digital logic circuitry	115	333	0	7	0.000	1.658	
400	Typewriting machines	212	206	0	4	0.000	1.531	
528	Synthetic resins or natural rubbers—part of the class 520 series	411	531	1	10	8.178	1.485	
355	Photocopying	422	753	0	14	0.000	1.466	
084	Music	101	220	0	4	0.000	1.434	
548	Organic compounds—part of the class 532-570 series	212	281	0	5	0.000	1.403	
359	Optics: systems (including communication) and element	549	1,083	0	19	0.000	1.383	
280	Land vehicles	285	581	0	9	0.000	1.222	
380	Cryptography	47	204	0	3	0.000	1.160	
347	Incremental printing of symbolic information	320	486	0	7	0.000	1.136	
523	Synthetic resins or natural rubbers—part of the class 520 series	277	210	0	3	0.000	1.127	
148	Metal treatment	225	352	0	5	0.000	1.120	
345	Selective visual display systems	159	356	0	5	0.000	1.108	
375	Pulse or digital communications	177	573	0	8	0.000	1.101	
427	Coating processes	555	691	0	9	0.000	1.027	
156	Adhesive bonding and miscellaneous chemical manufacture	546	779	0	10	0.000	1.012	
524	Synthetic resins or natural rubbers—part of the class 520 series	664	725	0	9	0.000	0.979	
372	Coherent light generators	127	364	0	4	0.000	0.867	
361	Electricity: electrical systems and devices	463	763	0	8	0.000	0.827	
333	Wave transmission lines and networks	167	213	0	2	0.000	0.740	
134	Cleaning and liquid contact with solids	84	224	0	2	0.000	0.704	
546	Organic compounds—part of the class 532-570 series	209	232	0	2	0.000	0.680	
549	Organic compounds—part of the class 532-570 series	214	235	0	2	0.000	0.671	
354	Photography	355	471	0	4	0.000	0.670	
364	Electrical computers and data processing systems	695	1,529	0	13	0.000	0.670	
239	Fluid sprinkling, spraying, and diffusing	230	240	0	2	0.000	0.657	
330	Amplifiers	247	241	0	2	0.000	0.654	
525	Synthetic resins or natural rubbers—part of the class 520 series	551	726	0	6	0.000	0.652	
271	Sheet feeding or delivering	174	726 247	0	2	0.000	0.632	
422	Chemical apparatus and process disinfecting, deodorizing,	174	241	U	۷	0.000	0.008	
422		211	EOG	Ω	1	0.000	0.600	
256	preserving, or sterilizing	211	526	0	4 5	0.000	0.600	
356 455	Optics: measuring and testing	340	669 403	0 0	3	0.000	0.589	
455	Telecommunications	158	403	U	ა	0.000	0.587	

NOTES: The activity index is the percentage of the patents in a class that are granted to inventors from one country, divided by the percentage of all patents that have inventors from that country in that year. Listing is limited to U.S. Patent and Trademark Office classes that received at least 200 patents from all countries in

Appendix table 6-18. Patents granted in selected countries, by inventor residence: 1985-95

						Percentag	Percentage of patents granted to residents of:	ranted to re	sidents of:			
	Total	Patents to non- residents as	United				United				Former Soviet	
Granting country	patents	percentage of total	States	Japan	Germany	France	Kingdom	Italy	Sweden	India	Union	Other
					1985	85						
Japan	50,100	15.5	46.4	0.0	19.6	6.4	5.4	1.5	2.3	0.0	1.4	17.0
Germany	33,377	60.4	29.5	23.9	0.0	12.4	6.7	2.8	2.8	0.0	1.7	20.5
France	37,530	73.8	27.4	15.8	25.9	0.0	5.9	4.1	2.4	0.0	1.3	17.0
United Kingdom	34,480	82.3	28.6	20.8	20.9	8.4	0.0	5.9	2.2	0.0	9.0	15.6
Italy	47,924	79.0	6.1	2.3	8.0	4.2	2.0	0.0	0.4	0.0	0.0	77.0
Canada	18,697	92.8	54.8	11.7	8.8	5.6	5.3	1.5	1.8	0.0	0.4	10.0
Mexico	1,374	93.4	56.3	9.9	7.6	7.0	4.0	5.6	1.5	0.0	0.5	14.0
Brazil	3,934	84.6	37.0	7.3	20.7	6.6	4.0	4.6	2.8	0.0	0.4	13.3
South Korea	2,268	84.6	30.4	42.3	6.2	5.4	3.5	9.	1.4	0.0	0.0	9.1
Soviet Union	74,745	2.0	13.7	8.4	16.9	8.2	3.1	3.9	2.7	0.0	0.0	42.9
India	1,814	76.2	33.5	6.4	11.2	8.1	10.1	3.4	1.3	0.0	3.0	23.0
					1990	06						
Japan	59,401	15.2	45.5	0.0	21.3	7.7	5.1	2.4	2.4	0.0	1.	14.4
Germany	42,860	61.2	27.8	28.4	0.0	10.8	6.5	3.7	2.7	0.0	0.7	19.3
France	35,149	74.6	24.9	18.2	26.9	0.0	0.9	4.2	2.2	0.0	9.0	17.0
United Kingdom	32,179	86.4	25.6	20.8	22.8	9.1	0.0	3.2	2.0	0.0	0.4	15.9
Italy	17,794	98.7	23.7	9.4	28.5	12.4	6.8	0.0	2.4	0.0	0.1	16.7
Canada	14,187	92.2	52.2	13.7	8.3	0.9	5.4	2.0	1.8	0.0	0.3	10.3
Mexico	1,752	92.0	63.4	5.4	7.3	5.1	3.2	2.4	0.8	0.1	0.2	12.2
Brazil	3,355	86.5	41.4	9.9	16.1	9.4	7.4	4.4	2.3	0.0	0.7	11.8
South Korea	7,762	67.1	23.0	2.99	2.5	1.8	0.8	- :	0.3	0.0	0.0	3.8
Soviet Union	84,658	1.4	12.0	8.1	18.8	7.8	3.6	6.7	3.8	0.0	0.0	39.2
India	1,611	81.0	35.3	9.3	14.6	6.2	7.8	3.1	1.2	0.0	3.4	19.1
					1994	94						
Japan	82,400	11.7	50.1	0.0	18.9	6.5	4.1	2.5	1.8	0.0	0.0	16.3
Germany	57,803	64.1	28.2	32.5	0.0	9.8	5.9	4.0	2.0	0.0	0.0	17.4
France	54,964	75.3	25.0	23.5	25.5	0.0	5.3	3.9	1.6	0.0	0.0	15.2
United Kingdom	48,772	89.3	24.9	25.7	22.0	8.0	0.0	3.3	1.5	0.0	0.0	14.5
Italy	37,096	85.5	24.8	13.4	27.6	10.2	5.9	0.0	1.9	0.0	0.1	16.1
Canada	11,641	92.7	51.3	18.8	9.7	5.6	4.6	1.5	1.0	0.0	0.0	9.5
Mexico	4,367	93.4	58.0	4.3 E.3	9.7	5.1	4.3	2.4	1.	0.0	0.0	14.9
Brazil	2,469	83.0	41.3	9.9	12.5	6.9	4.9	6.4	2.7	0.0	0.0	18.7
South Korea	11,683	50.6	22.9	62.6	3.9	2.5	1.1	0.8	0.5	0.0	0.0	5.8
Russian Federation	20,581	22.0	4.0	2.1	4.7	1.	0.8	7:	9.0	0.0	0:0	85.2
India	1,735	74.2	42.9	6.1	12.4	7.1	9.9	5.6	1.6	0.0	0.2	20.4
Dozo 1 of 0												Ţ

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Appendix table 6-18. Patents granted in selected countries, by inventor residence: 1985-95

						Percentaç	Percentage of patents granted to residents of	ranted to re	sidents of:			
Granting country	Total patents	Patents to non- residents as percentage of total	United States	Japan	Germany	France	United Kingdom	Italy	Sweden	India	Former Soviet Union	Other
					19.	1995						
Japan	109,100	13.1	A A	NA	ĄZ	₩ W	AN	A A	Ą	AA	Ą	₹ Z
Germany	56,633	65.2	ΑN	Ą	Ϋ́	Ϋ́	Ϋ́	Ą	Ϋ́	Ϋ́	Ą	ΑN
France	55,681	72.5	Ϋ́	Ϋ́	₹	Ϋ́Z	Ν	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ą
United Kingdom	48,350	89.2	ΑN	ΑN	Ϋ́	Ϋ́Z	ΝΑ	Ϋ́	ΑN	Ϋ́	Ϋ́	Ν
Italy	29,898	7.76	Ν Α	Ϋ́	ΑN	Ϋ́	ΑN	Ϋ́	ΑN	Ϋ́Z	Ϋ́	NA
Canada	9,139	91.9	Ϋ́	Ϋ́	Ϋ́	Ϋ́Z	Ν	Ϋ́	Ϋ́	Ϋ́	Ϋ́	ΑN
Mexico	3,538	92.8	ΑN	Ϋ́Z	Ϋ́	Ϋ́Z	ΝΑ	Ϋ́	ΝΑ	Ϋ́Z	Ϋ́	Ν
Brazil	2,659	80.3	ΑN	Ą	Ϋ́	Ϋ́	Ϋ́	Ą	Ϋ́	Ϋ́	Ą	Ą
South Korea	12,512	47.5	ΑN	ΑN	Ϋ́	Ϋ́	ΝΑ	Ϋ́	Ϋ́	Ϋ́	Ϋ́	Ν
Russian Federation	25,633	18.6	ΑN	ΑN	Ϋ́	Ϋ́Z	ΝΑ	Ϋ́	ΑN	Ϋ́	Ϋ́	Ν
India	1,613	74.3	ΑĀ	Ϋ́	∀ Z	Ϋ́	Y Y	Ą	Ϋ́	ΑĀ	Ą	₹ Z
111111111111111111111111111111111111111												

NA = not available

NOTE: German data are for the former West Germany only.

SOURCE: World Intellectual Property Organization, "Industrial Property Statistics" (Geneva: 1985-95).

See figures 6-18 and 6-19.

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Appendix table 6-19. Venture capital under management in the United States and disbursements: 1969-95

(Millions of U.S. dollars)

	lew capital	Total venture capital under management	Disbursements
1969	121	NA	100
1970	78	NA	83
1971	91	NA	134
1972	30	NA	128
1973	33	NA	201
1974	25	NA	100
1975	20	NA	92
1976	28	NA	107
1977	15	NA	159
1978	216	NA	288
1979	170	NA	457
1980	661	NA	608
1981	867	NA	1,155
1982	1,400	NA	1,454
1983	3,400	6,208	2,581
1984	3,200	9,497	2,771
1985	2,300	11,614	2,681
1986	3,300	14,693	3,242
1987	4,200	17,799	3,977
1988	2,947	20,217	3,847
1989	2,399	23,154	3,395
1990	1,847	24,139	1,922
1991	1,271	24,758	1,348
1992	2,548	25,868	2,540
1993	2,545	28,925	3,071
1994	3,765	32,670	2,741
1995	4,227	37,154	3,859

NA = not available

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

See figure 6-23.

Appendix table 6-20. Capital commitments by limited partners to institutionally funded independent private venture capital funds: 1978-95 (Millions of U.S. dollars)

	Total	Corporations	Endowments & foundations	Foreign investors	Individuals & families	Insurance companies	Pension funds
1978	216	22	19	38	70	35	32
1979	170	28	17	26	39	7	53
1980	661	127	92	55	102	88	197
1981	867	142	102	90	201	132	200
1982	1,423	175	96	188	290	200	474
1983	3,408	415	267	531	715	410	1,070
1984	3,185	463	178	573	467	419	1,085
1985	2,327	274	181	548	303	254	767
1986	3,332	350	209	361	392	348	1,672
1987	4,184	460	418	544	502	628	1,632
1988	2,947	324	341	401	249	277	1,355
1989	2,399	483	296	299	146	303	872
1990	1,847	125	232	138	211	171	970
1991	1,271	55	306	149	156	69	536
1992	2,548	84	471	283	280	370	1,060
1993	2,545	206	271	109	187	268	1,504
1994	3,765	341	805	91	444	357	1,727
1995	4,227	87	959	NA	741	784	1,656

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

Appendix table 6-21. U.S. venture capital disbursements, by industry category: 1986-95

Industry category	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
		Willi	Millions of U.S. d	dollars disbursed	sed					
Commercial communications	145	171	105	146	80	20	53	134	46	191
Telephone and data communications	346	306	369	342	268	169	366	384	294	399
Computer hardware and systems	550	523	422	354	259	168	138	86	171	183
Software and services	353	417	338	379	362	337	562	630	378	260
Other electronics	386	361	319	300	147	129	140	98	167	141
Biotechnology	183	265	322	245	181	112	261	283	303	205
Medical/health care related	335	481	451	522	380	152	442	437	473	547
Energy related	23	53	15	18	22	က	30	7	2	ဇ
Industrial automation	73	55	31	28	16	ო	7	30	16	26
Industrial products and machinery	118	183	198	192	77	47	77	54	26	125
Consumer related	285	642	425	392	225	135	196	314	173	405
Other products and services	445	520	852	477	284	83	271	613	663	874
Total	3,242	3,977	3,847	3,395	2,301	1,358	2,543	3,071	2,741	3,859
		Percentage of total venture	of total ventu	re capital dis	capital disbursements					
Commercial communications	4	4	က	4	က	2	2	4	2	2
Telephone and data communications	10	∞	о	10	12	12	14	13	7	10
Computer hardware and systems	17	13	1	10	1	12	2	က	9	2
Software and services	7	1	တ	1	16	25	22	21	14	20
Other electronics	12	6	80	တ	9	6	9	က	9	4
Biotechnology	9	7	∞	7	∞	80	10	6	7	2
Medical/health care related	10	12	12	15	17	7	17	14	17	14
Energy related	-	-	-	-	-	-	-	7	√	√
Industrial automation	7	-	-	-	-	-	-	-	∇	√
Industrial products and machinery	4	2	2	9	က	က	က	7	7	က
Consumer related	6	16	=	12	10	10	∞	10	9	Ξ
Other products and services	4	13	22	4	12	9	Ξ	20	24	23
Total	100	100	100	100	100	100	100	100	100	100

NOTE: Details may not sum to totals because of rounding.

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

See figure 6-24.

Science & Engineering Indicators – 1998

Appendix table 6-22. U.S. venture capital disbursements, by stage: 1986-95

Stage	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
		ı	Millions of	U.S. dollar	s disburse	d				
Seed	101	87	114	138	72	56	74	213	116	232
Startup	526	452	349	288	170	76	209	217	408	663
Other early stage	509	603	585	537	391	295	336	319	481	580
Expansion	1,416	1,773	1,510	1,596	1,194	734	1,400	1,668	1,232	1,614
Leveraged buyout/acquisition	601	804	1,127	710	414	46	176	172	166	338
Other	89	258	162	126	60	151	347	481	339	432
Total disbursements	3,242	3,977	3,847	3,395	2,301	1,358	2,542	3,070	2,741	3,859
		Percenta	ge of total	venture ca	pital disbu	rsements				
Seed	3	2	3	4	3	4	3	7	4	6
Startup	16	11	9	8	7	6	8	7	15	17
Other early stage	16	15	15	16	17	22	13	10	18	15
Expansion	44	45	40	47	52	54	55	54	45	42
Leveraged buyout/acquisition	18	20	29	21	18	3	7	6	0	9
Other	3	7	4	4	3	11	14	16	12	11
Total	100	100	100	100	100	100	100	100	100	100

NOTE: Details may not sum to totals because of rounding.

SOURCE: Venture Economics, 1996 Venture Capital Annual Review (Boston: 1996).

See figure 6-25.

Appendix table 6-23. **Leading indicators of technological competitiveness: 1996** (Index)

Region/country	National orientation	Socioeconomic infrastructure	Technological infrastructure	Productive capacity
Singapore	88.4	75.7	41.6	54.0
South Korea	78.9	64.6	44.4	50.6
Taiwan	90.2	75.8	42.9	49.9
China	65.3	44.8	39.3	32.8
India	57.4	46.0	39.3	49.1
Indonesia	54.8	35.2	17.8	19.6
Malaysia	81.0	62.5	31.9	43.1
Philippines	73.6	66.2	35.3	48.1
Thailand	63.5	48.7	28.2	33.1
Hungary	67.0	47.7	36.4	39.8
Poland	69.7	57.4	38.1	39.8
Russia	48.9	50.7	55.6	42.6
Argentina	41.5	49.4	27.4	31.0
Brazil	60.0	53.1	37.4	40.3
Mexico	54.8	45.5	30.2	31.7
Venezuela	56.6	55.2	38.4	40.7
South Africa	49.2	51.0	40.3	30.0

NOTES: For score and indicator calculations, raw data were transformed into scales of 0-100 for each indicator component and then averaged to generate comparable indicators with a 0-100 range. For survey items, 100 represents the highest response category for each question; for statistical data, 100 typically represents the value attained by the country with the largest value among the 30 countries included in the study. In the indicator formulations cited below, each term carries equal weight.

National orientation (NO)—evidence that a nation is taking directed action to achieve technological competitiveness. These actions could take place in the business, government, or cultural sector, or any combination of the three.

Indicator formulation: NO = Q1 + (Q2 + Q3)/2 + Q4 + F1V96

Data used: Published data from Frost and Sullivan's "Political Risk Letter" for 1996 rating each country's investment risk (F1V96); and survey data assessing each country's national strategy to promote high-tech development (Q1), social influences favoring technological change (Q2 and Q3), and entrepreneurial spirit (Q4).

Socioeconomic infrastructure (SE)—assesses the social and economic institutions that support and maintain the physical, human, organizational, and economic resources essential to the functioning of a modern, technology-based industrial nation.

Indicator formulation: SE = Q5 + Q10 + HMHS93

Data used: Published data on the percentage of students enrolled in secondary and tertiary education (HMHS93) from the Harbison-Myers Skills Index for 1993; and survey data assessing each country's efforts to attract foreign investment (Q10) and the mobility of capital (Q5).

Technological infrastructure (TI)—assesses the institutions and resources that contribute to a nation's capacity to develop, produce, and market new technology.

Indicator formulation: TI = (Q7 + Q8)/2 + Q9 + Q11 + EDP96 + S&E

Data used: Published data from UN Statistical Yearbook on the number of scientists and engineers involved in research (S&E), national purchases of electronic data processing equipment (EDP96) from Elsevier Yearbook of World Electronics Data (1996); and survey data assessing linkages of R&D to industry (Q9), output of indigenous academic science and engineering (Q7and Q8), and ability to make effective use of technological knowledge (Q11).

Productive capacity (PC)—assesses the phsical and human resources devoted to manufacturing products and the efficiency with which those resources are employed.

Indicator formulation: PC = Q6 + Q12 + Q13 + A2696

Data used: Published data on electronics production (A2696) from Elsevier Yearbook of World Electronics Data (1996); and survey data assessing the supply and quality of skilled labor (Q6), capability of the indigenous management (Q13), and the existence of indigenous suppliers of components for technology-intensive products (Q12).

SOURCE: J. David Roessner, Alan L. Porter, Nils Newman, and Honguang Xu, 1996 Indicators of Technology-Based Competitiveness of Nations, Summary Report, report to the National Science Foundation under Purchase Order No. D22588X-00-0 (Atlanta: Georgia Institute of Technology, 1997).

See figure 6-27.

Appendix table 7-1.
Indices of issue interest: 1979-97
(Mean index scores)

Issue	1979	1981	1983	1985	1988	1990	1992	1995	1997
Foreign policy	49	59	54	59	58	89	62	48	47
New scientific discoveries	61	09	89	99	99	63	61	29	70
New technologies	59	28	65	64	64	64	64	99	69
Space exploration	ı	47	20	52	26	20	47	20	55
Energy/nuclear powera	29	70	62	61	61	64	22	54	54
Medical discoveries	ı	ı	ı	83	82	83	82	83	83
Environmental issues	ı	ı	I	ı	ı	80	77	74	72
Economic policy	29	71	74	69	69	70	74	89	89
Sample size	1,635	3,195	1,631	2,005	2,041	2,033	2,001	2,006	2,000

- = not asked

NOTES: Each index is a summary measure of respondent reports that they are "very interested," "moderately interested," or "not at all interested" in each specific issue. Responses are to the statement: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested." The original responses were converted to a 0-100 index by assigning a value of 100 for a "very interested" response and a value of 50 for a "moderately interested" response.

aln 1990, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear energy policy." In 1988, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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See figure 7-1.

Appendix table 7-2. **Public interest in selected issues: 1979-97**(Percentages)

		1979			1981			1983			1985		-	1988		15	1990		19	1992		1995	5		1997	
Issue	=	N IM NI MI NI	z	=	₹	Į≅	=	₹	≅		≅	=		Ī	-		_ 	> Z	2	\ ₹	>	Σ	Z		₹	Ξ
Foreign policy	22	22 53 24 35 47 18	24	35	47	18	<u>ه</u>	47	22	33			33	50 1		48 4	40	2 38		47 15	``	53	26	22	20	78
New scientific discoveries	36	49	4	37	45	17	48	40	Ξ	44	44		43			39 4	48 1	12 36	36 49	49 15	5 44		Ξ	49	42	œ
New technologies	33	51	15	33	20	16	42	45	12	33										3 10						
Space exploration	ı	ı	ı	25	44	ઝ		45	28	53	46	25 (8			26 4				50 28						
Energy/nuclear powera	46	45	F	20	40	우	39	46	4	36		13	38	46 1	16 ,	42 4		4 32		9 18	3 29		21	29		
Medical discoveries	ı	ı	ı	ı	ı	ı	ı	ı	ı	89	29	ო											4	70		
Environmental issues	ı	ı	ı	ı	ı	1	ı	1	1	ı	1	1	ı		ı								9	52		
Economic policy	32	48	17	25	37	10	22	33	10	48	14	7	48	42	01	50 4	40 1	10 56		36 8		, 42	Ξ	47	45	
Sample size		1,635			3,195		-	,631		2	2,005		2,	2,041		2,0	2,033		2,00	10		2,00	9		2,000	

VI = very interested; MI = moderately interested; NI = not at all interested; - = not asked

NOTES: Responses are to the statement: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested." "Don't know" responses are not included. Percentages may not total 100 because of rounding. and 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-3. **Mean score on indices of interest in scientific and technological issues, by sex and level of education: 1997** (Mean index scores)

Sex and level of education	New scientific discoveries	New technologies	Medical discoveries	Space exploration	Nuclear energy	Environmental issues	Sample size
All adults	70	69	83	55	54	72	2,000
Sex							
Male	71	73	81	63	55	70	930
Female	70	65	86	49	54	75	1,070
Formal education							
Less than high school	61	56	79	42	54	70	420
High school graduate	70	70	85	56	53	73	1,188
Baccalaureate degree	78	75	86	66	58	74	257
Graduate/professional degree	84	80	87	67	62	79	135
Science/mathematics education ^a							
Low	64	62	83	48	51	71	1,112
Middle	75	73	85	58	57	74	509
High	84	81	85	72	61	74	379

NOTES: Each index is a summary measure of respondent reports that they are "very interested," "moderately interested," or "not at all interested" in each specific issue. A value of 100 was assigned to a "very interested" response, and a value of 50 was assigned to a "moderately interested" response.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-2.

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

Appendix table 7-4. Indices of issue informedness: 1979-97 (Mean index scores)

Issue	1979	1981	1983	1985	1988	1990	1992	1995	1997
Foreign policy	35	44	40	42	42	51	46	36	36
New scientific discoveries	36	38	40	43	42	42	39	42	49
New technologies	35	35	42	39	38	38	38	40	44
Space exploration	ı	37	39	42	39	37	33	33	41
Energy/nuclear power ^a	47	51	47	44	37	37	32	29	31
Medical discoveries	ı	1	ı	53	52	53	51	52	26
Environmental issues	ı	1	ı	ı	ı	09	22	52	51
Economic policy	42	55	54	48	20	53	56	52	51
Sample size	1,635	3,195	1,631	2,005	2,041	2,033	2,001	2,006	2,000

- = not asked

NOTES: Each index is a summary measure of respondent reports that they are "very well-informed," "moderately well-informed," or "poorly informed," about each specific issue. Responses are to the statement: "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed, or poorly informed." The original responses were converted to a 0-100 index by assigning a value of 100 for a "very well-informed" response and a value of 50 for a "moderately well-informed" response.

aln 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear energy policy." In 1988, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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See figure 7-3.

Appendix table 7-5. **Public informedness on selected issues: 1979-97**(Percentages)

		1979			1981		<u> </u>	1983			1985			1988		~	1990		131	1992		19	1995		19	1997	I
Issue		N IN IN IN IN	≥		₹	Z	>	₹	Z		₹	≥		≅	Į		Ξ	> Z	_	<u> </u>	Z	_	Σ	-	V	=	Į
Foreign policy	ω	54	37	54 37 17 54	54	78	41	51	35	15	53	32	4		31		25										_∞
New scientific discoveries	10	52	37	13	49	38	13	23	34	13	29	27	4		3										19 5		က္သ
New technologies	10	20	33	Ξ	48	40	4	22	32	12	54	34	12	51	36	=	53	35 1	10 5		33 1	12 5		33 1			28
Space exploration	ı	ı	ı	4	46	40	5	25	34	16	52	35	13												16 5		4
Energy/nuclear power ^a	18	28	23	33	26	21	19	26	24	16	22	59	13			12	20					9					<u>6</u>
Medical discoveries	ı	ı	ı	ı	ı	ı	ı	1	ı	24	22	8	22														9
Environmental issues	ı	ı	ı	ı	ı	ı	ı	1	ı	ı	ı	ı	ı														Σ.
Economic policy	4	22	31	59	21	50	28	25	20	22	21	56	22	22			22			54			23			51 2	4
Sample size		1,635			3,195		1-	1,631		. 4	2,005		Ø	2,041		2,	033		2,(201		2,0	900		2,0	00	

VI = very well-informed; MI = moderately well-informed; NI = poorly informed; - = not asked

NOTES: Responses are to the statement: "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed, or poorly informed." "Don't know" responses are not included. Percentages may not total 100 because of rounding.

and 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-6.

Mean score on indices of informedness on scientific and technological issues, by sex and level of education: 1997 (Mean index scores)

Sex and level of education	New scientific discoveries	New technologies	Medical discoveries	Space exploration	Nuclear energy	Environmental issues	Sample size
All adults	49	44	56	41	31	51	2,000
Sex							
Male	51	47	52	49	33	52	930
Female	47	41	60	34	28	50	1,070
Formal education							
Less than high school	45	42	58	36	38	54	420
High school graduate	47	43	55	41	28	49	1,188
Baccalaureate degree	55	49	57	46	29	52	257
Graduate/professional degree	60	54	61	50	34	58	135
Science/mathematics education ^a							
Low	44	41	56	37	30	50	1,112
Middle	48	45	54	43	30	53	509
High	63	54	61	53	32	53	379

NOTES: Each index is a summary measure of respondent reports that they are "very well-informed," "moderately well-informed," or "poorly informed" about each specific issue. A value of 100 was assigned to a "very well-informed" response, and a value of 50 was assigned to a "moderately well-informed" response.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-2.

aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

Appendix table 7-7. **Public attentiveness to selected issues: 1979-97** (Percentages)

Issue	1979	1981	1983	1985	1988	1990	1992	1995	1997
Foreign policy									
Attentive public	6	6	8	8	8	14	11	5	5
Interested public	16	29	23	25	25	34	27	16	18
Residual public	78	65	70	67	67	52	62	79	77
New scientific discoveries									
Attentive public	7	9	9	8	8	8	7	7	11
Interested public	29	28	40	36	34	31	29	37	38
Residual public	64	63	52	56	57	61	64	56	51
New inventions & technologies									
Attentive public	6	8	8	8	7	7	6	6	9
Interested public	27	26	34	31	33	32	30	37	38
Residual public	67	67	58	61	60	61	63	57	53
Science and technology policy ^a									
Attentive public	9	12	13	12	11	11	10	10	14
Interested public	37	35	48	44	42	40	40	47	46
Residual public	54	54	39	45	46	49	50	43	40
Space exploration									
Attentive public	_	7	7	9	8	6	5	5	8
Interested public	_	18	20	20	26	20	17	20	24
Residual public	_	75	73	71	66	74	78	75	68
Energy/nuclear power ^b							. •		
Attentive public	_	_	15	9	8	8	6	4	4
Interested public	_	_	25	28	30	34	26	25	25
Residual public	_	_	61	63	62	58	68	71	71
Medical discoveries			01	00	OL.	00	00	, ,	, ,
Attentive public	_	_	_	17	16	16	17	15	19
Interested public	_	_	_	51	56	52	49	53	52
Residual public	_	_	_	32	28	32	34	31	29
Environmental issues				02	20	02	0-1	01	23
Attentive public	_	_	_	_	_	20	18	13	12
Interested public	_	_	_	_	_	43	41	40	40
Residual public	_	_	_	_	_	36	41	48	48
Economic policy	_	_	_	_	_	30	41	40	40
Attentive public	9	12	19	16	15	17	19	15	14
Interested public	9 26	40	38	32	33	34	38	32	32
•	26 65	40 48	36 43	32 52	52	50	36 44	3∠ 53	3∠ 54
Residual public	60	48	43	52	52	50	44	53	54
Sample size	1.635	3,195	1,631	2,005	2,041	2,033	2,001	2,006	2,000

^{- =} not asked

NOTES: Responses are to the statements: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like you to tell me if you are very interested, moderately interested, or not at all interested"; "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed, moderately well-informed, or poorly informed"; and "Now let me change the topic slightly and ask you how you get information. First, how often do you read a newspaper: every day, a few times a week, once a week, or less than once a week? Are there any magazines that you read regularly, that is, most of the time? What magazine would that be? Is there another magazine that you read regularly? What magazine would that be?" Percentages may not total 100 because of rounding.

To be classified as attentive to a given issue area, respondents must indicate that they are "very interested" in that area, that they are "very well-informed" about it, and that they regularly read a daily newspaper or relevant national magazine. Citizens who report that they are "very interested" in an issue area, but who do not think that they are "very well-informed" about it, are classified as the "interested public." All other individuals are classified as members of the "residual public" for that issue area.

^aThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

bln 1990, 1992, 1995, and 1997 the question was worded "...issues about the use of nuclear energy to generate electricity." From 1979 to 1985, the question was worded "...issues about energy policy." In 1988, the question was worded "...issues about the use of nuclear power to generate electricity."

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-4.

Public attentiveness to scientific and technological issues, by sex and level of education: 1997 Appendix table 7-8. (Percentages)

	New scientific discoveries	ientific veries	New technologies	n ogies	Science and technology policy ^a	and policy ^a	Medical discoveries	ical eries	Space exploration	ce ation	Nuclear	ear gy	Environmenta issues	nental es	
Sex and level of education	АР		АР	_	AP	۵	AP	_	АР	≗	АР	≗	АР	₾	Sample size
All adults	1	38	o	38	14	46	19	52	ω	24	4	25	12	40	2,000
Male	12	39	11	43	16	49	15	51	14	28	2	24	14	35	930
FemaleFormal education	ი	38	7	34	13	43	23	53	4	20	ო	56	=	45	1,070
Less than high school	о	32	တ	25	15	34	21	43	9	18	9	27	10	41	420
High school graduate	о	39	ω	40	12	49	16	26	80	24	က	24	Ξ	41	1,188
Baccalaureate degree	15	43	10	46	18	51	24	48	13	30	2	56	16	37	257
degreeScience/mathematics education ^b	23	47	22	4	30	49	24	51	16	25	∞	59	22	40	135
Low	7	34	9	33	10	42	18	51	9	19	က	24	Ξ	41	1,112
Middle	6	43	6	4	4	20	16	22	7	27	9	25	12	4	209
High	22	47	17	47	28	20	25	48	17	34	9	27	17	37	379

AP = attentive public; IP = interested public

week, or less than once a week? Are there any magazines that you read regularly, that is, most of the time? What magazine would that be? Is there another magazine that you read regularly? What magazine would NOTES: Responses are to the statements: "There are a lot of issues in the news, and it is hard to keep up with every area. I'm going to read to you a short list of issues, and for each one—as I read it—I would like moderately well-informed, or poorly informed"; and "Now let me change the topic slightly and ask you how you get information. First, how often do you read a newspaper: every day, a few times a week, once a you to tell me if you are very interested, moderately interested, or not at all interested": "Now I'd like to go through this list with you again, and for each issue I'd like you to tell me if you are very well-informed,

ō To be classified as attentive to a given issue area, respondents must indicate that they are "very interested" in that area, that they are "very well-informed" about it, are classified as the "interested public." All other relevant national magazine. Citizens who report that they are "very interested public." All other individuals are classified as members of the "residual public" for that issue area. "The attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technology. All other individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

PRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-5.

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U.S. public understanding of scientific vocabulary and concepts, by selected characteristics: 1997 Appendix table 7-9. (Percentages)

	<	ω	O	٥	ш	ш	g	I	_	_	~		Σ	z	0	۵	Ø	œ	S	S –	Sample size
All adults	82	71	84	62	39	44	43	32	78	44	93	51	29	. 92	73	48	22	=	13	11 ,	2,000
Sex Male Female	89	80	88	54 69	56 24	53 36	36 49	39 26	86	50 38	94 92	53 49	67	88	82	58 40	26	17	16 11	16	930
Formal education Less than high school	75	55	77	4	25	25	20	25	29	38	91	37	44	61	21	59	œ	-	2	-	420
graduate	82	71	86	99	35	42	43	30	78	40	93	52	61	. 92	15	49	18	o	12	თ	1,188
baccalaureate degree	88	88	88	72	62	99	64	43	98	25	93	09	69	84	98	62	8	28	25	21	257
professional degree	06	95	82	75	89	20	71	49	96	89	96	69	78	06	91	72	49	30	23	33	135
Science/mathematics education ^a Low	76 86 93	60 78 94	80 91 87	57 64 77	28 40 70	29 49 79	33 47 67	28 30 45	72 80 92	38 41 64	95 96 96	42 58 68	54 61 73	67 (81 8	62 81 93	35 56 77	9 25 56	3 12 36	9 12 27	4 L E	1,112 509 379
Attentiveness to science and technology ^b Attentive public Interested public	89 85 75	86 75 61	88 84 82	61 66 58	56 43 27	56 33	49 47 36	45 34 25	87 81 71	63 46 35	94 93	59 54 45	66 64	78 87 78 77 0	85 76 64	66 51 39	36 25 13	21 14 5	23 8 8	23 11 6	288 918 794

NOTE: Understanding is determined by correct responses to the following statements:

boiling it." (False); N = "Which travels faster: light or sound?" (Light); O = "Does the earth go around the sun, or does the sun go around the earth?" (earth around the sun); P = "How long does it take for the earth to go around the sun: one day, one month, or one year?" (One year); Q = "Please tell me, in your own words, what is DNA?"; R = "Please tell me, in your own words, what is a molecule?"; S = "Please tell me, in your boy or a girl." (True); E = "Lasers work by focusing soundwaves." (False); F = "Electrons are smaller than atoms." (True); G = "Antibiotics kill viruses as well as bacteria." (False); H = "The universe began with a huge A = "The center of the earth is very hot." (True); B = "All radioactivity is man-made." (False); C = "The oxygen we breathe comes from plants." (True); D = "It is the father's gene which decides whether the baby is a explosion." (True); I = "The continents on which we live have been moving their location for millions of years and will continue to move in the future." (True); J = "Human beings, as we know them today, developed from earlier species of animals." (Tue); K = "Gigarette smoking causes lung cancer." (True); L = "The earliest humans lived at the same time as the dinosaurs." (False); M = "Radioactive milk can be made safe by own words, what is the Internet?"; T = "Please tell me, in your own words, what is radiation?

"PRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer. ^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-6.

Appendix table 7-10. Mean score on Index of Scientific Construct Understanding, by selected characteristics: 1997 (Mean index scores)

Characteristic	Mean score
All adults	55
Sex	
Male	62
Female	49
Formal education	
Less than high school	44
High school graduate	54
Baccalaureate degree	68
Graduate/professional degree	72
Science/mathematics education ^a	
Low	47
Middle	58
High	74
Attentiveness to science and technology ^b	
Attentive public	65
Interested public	58
Residual public	48

NOTE: The Index of Scientific Construct Understanding is a composite measure of the public understanding of scientific terms and concepts. In 1997, this measure included responses to the following true/false questions: "All radioactivity is man-made"; "Electrons are smaller than atoms"; "The earliest humans lived at the same time as the dinosaurs"; and "The continents on which we live have been moving their location for millions of years and will continue to move in the future." The following short-answer items were also included: "Which travels faster: light or sound?"; "Does the earth go around the sun, or does the sun go around the earth?"; and "How long does it take for the earth to go around the sun: one day, one month, or one year?" Coded verbatim responses to the following open-ended questions were also included: "Please tell me, in your own words, what is DNA?"; "Please tell me, in your own words, what is radiation?"

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

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Appendix table 7-11. **Public understanding of the nature of scientific inquiry, by selected characteristics: 1997** (Percentages)

Characteristic	Percentage
All adults	27
Sex	
Male	29
Female	25
Formal education	
Less than high school	8
High school graduate	27
Baccalaureate degree	46
Graduate/professional degree	54
Science/mathematics education ^a	
Low	16
Middle	30
High	55
Attentiveness to science and technology ^b	
Attentive public	35
Interested public	31
Residual public	20

NOTE: Responses are to the following questions: "Now, think about this situation. A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple's children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?" "Now, let me turn to a slightly different type of question. When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term 'scientific study,' do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means? (if clear understanding or general sense): In your own words, could you tell me what it means to study something scientifically?" "Now, please think about this situation. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many of them experience lower blood pressure. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?"

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-12. Mean score on Index of Scientific Construct Understanding in 14 industrialized nations: Most recent year

Country (year)	Mean index score	Sample size
United States (1997)	55	2,000
United States (1995)	55	2,000
United States (1990)	54	2,033
Denmark (1992)	55	1,000
The Netherlands (1992)	54	1,000
Great Britain (1992)	53	1,000
France (1992)	52	1,000
Germany (1992)	51	2,000
Belgium (1992)	49	1,000
Italy (1992)	47	1,000
Canada (1989)	46	2,000
Spain (1992)	45	1,000
Ireland (1992)	42	1,000
Greece (1992)	37	1,000
Japan (1991)	36	1,457
Portugal (1992)	33	1,000

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology*, 1979-1997, *Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); J.D. Miller, "Public Understanding of Science and Technology in OECD Countries: A Comparative Analysis," paper presented to the 1996 OECD Symposium on Public Understanding of Science and Technology, Tokyo; and J.D. Miller, R. Pardo, and F. Niwa, *Public Attitudes Toward Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Madrid: BBV Foundation, 1997).

See figure 7-10.

Appendix table 7-13. **General attitudes toward science and technology, by selected characteristics: 1992, 1995, and 1997** (Mean index scores)

		1992			1995			1997	
Characteristic	Pa	Rb	P/R	Pa	R⁵	P/R	Pa	Rb	P/R
All adults	67	38	1.76	68	39	1.74	70	37	1.89
Sex									
Male	68	39	1.74	69	38	1.82	71	35	2.03
Female	67	38	1.76	67	40	1.68	69	39	1.77
Formal education									
Less than high school	64	49	1.31	63	51	1.24	69	45	1.53
High school graduate	67	39	1.72	68	39	1.74	69	38	1.82
Baccalaureate degree	70	27	2.59	71	29	2.45	74	28	2.64
Graduate/professional degree	71	24	2.96	73	24	3.04	75	24	3.13
Science/mathematics education ^c									
Low	66	43	1.53	67	44	1.52	69	42	1.64
Middle	67	38	1.76	69	35	1.97	71	34	2.09
High	71	24	2.96	71	28	2.54	75	27	2.78
Attentiveness to science and technology ^d									
Attentive public	71	36	1.97	74	30	2.47	75	30	2.50
Interested public	70	36	1.94	69	38	1.82	73	35	2.09
Residual public	65	41	1.59	65	42	1.55	66	43	1.54

P = Index of Scientific Promise; R = Index of Scientific Reservations; P/R = ratio of scores on the two indices

^aThe Index of Scientific Promise includes responses to the following statements: "Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree. If you feel especially strongly about a statement, please tell me that you strongly agree or strongly disagree. First, science and technology are making our lives healthier, easier, and more comfortable—do you strongly agree, agree, disagree, or strongly disagree? Most scientists want to work on things that will make life better for the average person—do you strongly agree, disagree, or strongly disagree? With the application of science and new technology, work will become more interesting—do you strongly agree, disagree, or strongly disagree? Because of science and technology, there will be more opportunities for the next generation—do you strongly agree, disagree, or strongly disagree?"

bThe Index of Scientific Reservations includes responses to the following statements: "Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree. If you feel especially strongly about a statement, please tell me that you strongly agree or strongly disagree. We depend too much on science and not enough on faith—do you strongly agree, agree, disagree, or strongly disagree? It is not important for me to know about science in my daily life—do you strongly agree, agree, disagree, or strongly disagree? Science makes our way of life change too fast—do you strongly agree, agree, disagree, or strongly disagree? Now for a different type of question. People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits? (if benefits greater): Would you say that the balance has been strongly in favor of beneficial results, or only slightly?"

Respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

^dThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-14.

Responses to items in the Index of Scientific Promise and the Index of Scientific Reservations: 1997 (Percentages)

Item	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
Index of Scientific Promise					
Science and technology are making our lives					
healthier, easier, and more comfortable	29	60	2	7	2
Most scientists want to work on things					
that will make life better for the average person	11	68	4	15	2
With the application of science and new technology,					
work will become more interesting	9	63	6	21	1
Because of science and technology, there will be					
more opportunities for the next generation	13	68	4	14	1
Index of Scientific Reservations					
We depend too much on science and not enough on faith	12	35	6	39	8
It is not important for me to know about science in my					
daily life	2	12	1	58	27
Science makes our way of life change too fast	4	32	2	55	6
	B>>H	B>H	B=H	H>B	H>>B
Have the benefits of scientific research outweighed the					
harmful results or have the harmful results outweighed					
the benefits?	47	28	13	8	4

B>>H = benefits strongly outweigh the harmful results; B>H = benefits outweigh the harmful results; B=H = benefits equal the harmful results; H>B = harmful results outweigh the benefits; H>B = harmful results outweigh the benefits

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-15.

Responses to and mean scores on the Attitude Toward Organized Science Scale, by selected characteristics: 1983-97

Response and characteristic	1983	1985	1988	1990	1992	1995	1997
	Perce	ntage of the	public				
Agree that "science and technology are making our lives healthier easier, and more comfortable"	84	86	87	84	85	86	89
Agree that "the benefits of science are greater than any harmful effects"	57	68	76	72	73	72	75
Disagree that "science makes our way of life change too fast"	50	53	59	60	63	60	61
Disagree that "we depend too much on science and not enough on faith"	43	39	43	44	45	44	48
	Ме	an ATOSS so	ore				
All adults	2.3	2.5	2.7	2.6	2.7	2.6	2.7
Sex Male Female	2.2 2.5	2.4 2.6	2.6 2.8	2.5 2.8	2.7 2.6	2.7 2.5	2.9 2.6
Formal education Less than high school	1.8	1.8	2.2	1.8	2.0	2.0	2.2
High school graduate Baccalaureate degree Graduate/professional degree	2.4 2.9 2.9	2.6 3.1 3.1	2.8 3.2 3.1	2.7 3.1 3.2	2.7 3.3 3.3	2.6 3.3 3.4	2.7 3.2 3.4
Science/mathematics education ^a	NA	NA	NA	2.4	2.5	2.3	2.5
Low	NA NA NA	NA NA NA	NA NA NA	2.4 2.9 3.3	2.5 2.7 3.3	2.3 2.9 3.2	2.5 2.9 3.3
Attentiveness to science and technology ^b							
Attentive public	2.6 2.4 2.1	2.8 2.6 2.3	3.0 2.8 2.5	2.8 2.7 2.5	2.9 2.8 2.5	3.1 2.7 2.4	3.0 2.9 2.4
Sample size	1,631	2,005	2,041	2,033	997	2,006	2,000

ATOSS = Attitude Toward Organized Science Scale; NA = not available

NOTES: Responses are to the following statement: "Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree. If you feel especially strongly about a statement, please tell me that you strongly agree or strongly disagree." The scale is a count of agreement with the first two items and disagreement with the second two items.

^aRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated* Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 7-16. General attitudes toward science and technology in 14 industrialized nations: Most recent year (Mean index scores)

Country (year)	Index of Scientific Promise	Index of Scientific Reservation	Ratio of indices
United States (1997)	70	37	1.89
United States (1995)	68	39	1.74
United States (1992)	67	38	1.76
Canada (1989)	72	56	1.29
Italy (1992)	69	54	1.28
Ireland (1992)	69	55	1.26
Great Britain (1992)	68	56	1.21
France (1992)	68	56	1.21
Belgium (1992)	64	54	1.19
Denmark (1992)	72	61	1.18
The Netherlands (1992)	69	59	1.17
Germany (1992)	70	60	1.17
Spain (1992)	71	62	1.15
Portugal (1992)	71	67	1.06
Greece (1992)	75	74	1.01
Japan (1991)	55	56	0.98

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); unpublished tabulations; and J. D. Miller, R. Pardo, and F. Niwa, *Public Attitudes Toward Science and Technology: A Comparative Study of the European Union, the United States, Japan, and Canada* (Madrid: BBV Foundation, 1997).

Appendix table 7-17. Public assessments of funding of scientific research by the Federal Government, by selected characteristics: 1985-97 (Percentages)

Characteristic	1985	1988	1990	1992	1995	1997
All adults						
Strongly agree	9	16	17	14	19	22
Agree	70	65	62	63	61	57
Don't know	5	4	4	3	3	3
Disagree	16	14	15	18	17	15
Strongly disagree	0	1	2	2	2	3
Male						
Strongly agree	11	20	23	17	19	24
Agree	71	63	60	62	60	54
Don't know	2	2	2	2	2	3
Disagree	15	13	13	_ 17	18	16
Strongly disagree	1	2	2	2	1	3
Female	•	2	2	2	'	0
Strongly agree	8	11	13	11	15	20
	68	68	65	64	62	59
Agree Don't know	8	6	5	4	5	4
				•		· ·
Disagree	16	14	16	19	16	15
Strongly disagree	0	1	1	2	2	2
Less than high school graduate	_		40	40		
Strongly agree	5	6	10	10	8	20
Agree	65	66	59	61	59	50
Don't know	9	7	8	5	7	5
Disagree	21	18	20	21	24	22
Strongly disagree	0	3	3	3	2	3
High school graduate						
Strongly agree	8	17	18	12	16	19
Agree	72	66	65	64	63	60
Don't know	4	3	2	3	3	3
Disagree	15	13	14	19	17	15
Strongly disagree	1	1	1	2	1	3
Baccalaureate degree						
Strongly agree	19	26	27	22	24	31
Agree	68	62	60	64	62	56
Don't know	2	3	2	2	2	2
Disagree	10	8	10	12	11	10
Strongly disagree	1	1	1	0	1	1
Graduate/professional degree						
Strongly agree	20	29	31	26	43	40
Agree	70	61	58	53	46	51
Don't know	2	2	4	5	2	2
Disagree	8	7	6	14	8	5
Strongly disagree	0	1	1	2	1	2
Attentive public for science and technology	U	ı	ı	۷	1	۷
	17	27	35	28	35	46
Strongly agree	76			∠o 61		
Agree		62	50	- -	48	42
Don't know	0	2	4	1	1	1
Disagree	6	8	10	9	14	7
Strongly disagree	1	1	1	1	2	4

NOTE: Responses are to the question: "Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary and should be supported by the Federal Government. Do you strongly agree, agree, disagree, or strongly disagree?"

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

Appendix table 7-18. **Public attitudes toward federal support of basic scientific research, by general attitudes on science and technology and selected characteristics: 1997**(Percentages)

Characteristic	Disagree	Unsure	Agree	Sample size	Gammaª
INDEX OF SCIENTIFIC PROMISE ^b					
All adults	18	3	79	2,000	_
Low score on Index of Scientific Promise	37	9	54	241	
Moderate score on Index of Scientific Promise	25	4	71	626	0.54
High score on Index of Scientific Promise	10	1	89	1,133	
Less than high school graduate	25	5	70	421	_
Low score	35	18	47	57	
Moderate score	39	4	57	147	0.51
High score	14	1	85	217	
High school graduate	18	4	78	1,188	_
Low score	41	7	52	152	
Moderate score	23	5	72	379	0.54
High score	10	2	88	657	
Baccalaureate degree	10	2	88	393	_
Low score	21	6	73	33	
Moderate score	14	2	84	100	0.42
High score	7	1	92	260	
INDEX OF SCIENTIFIC RESERVATIONS°					
All adults	18	3	79	2,000	_
Low score on Index of Scientific Reservations	9	1	90	831	
Moderate score on Index of Scientific Reservations	23	4	73	806	-0.43
High score on Index of Scientific Reservations	27	6	67	363	
Less than high school graduate	25	4	71	421	_
Low score	8	0	92	79	
Moderate score	37	5	58	218	-0.07
High score	16	6	78	122	
High school graduate	18	3	79	1,188	_
Low score	9	2	89	493	
Moderate score	20	4	76	478	-0.47
High score	33	7	60	217	
Baccalaureate degree	10	1	89	393	_
Low score	8	1	91	254	
Moderate score	10	3	87	109	-0.27
High score	21	4	75	24	

^aThe ordinal correlation coefficient gamma is a measure of the bivariate relationship between two ordinal variables. It is equivalent to R² for two interval variables. See L.A. Goodman and W.H. Kruskal "Measures of Association for Cross-Classifications," *Journal of the American Statistical Association* Vol. 49 (1954): 732-64; and H.L. Costner, "Criteria for Measures of Association," *American Sociological Review* Vol. 30, No. 3 (1965): 341-53.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-11.

^bThe Index of Scientific Promise scores are classified as follows: low = 0-49; moderate = 50-74; and high = 75-100.

[°]The Index of Scientific Reservations scores are classified as follows: low = 0-29; moderate = 30-54; and high = 55+.

Appendix table 7-19. **Public confidence in the people running various institutions: 1973-96** (Percentages)

Institution	1973	1973 1974 1975	1975	1976	1977	1978	1980	1982	1983	1984	1986	1987	1988	1989	1990	1991	1993	1994	1996
Average ^a	30	33	26	29	31	24	26	26	24	27	25	28	26	25	25	59	22	22	23
Medicine	54	9	20	24	51	46	25	45	51	20	46	25	51	46	46	48	39	41	45
Scientific community	37	45	39	43	4	36	41	38	41	44	33	45	39	40	37	41	37	38	39
U.S. Supreme Court	31	33	31	35	35	28	25	30	27	33	30	36	35	34	35	37	31	30	28
Military	35	40	35	33	36	59	28	31	59	36	31	34	34	32	33	09	42	37	37
Education	37	49	31	37	4	28	30	33	59	28	28	35	59	30	27	30	22	25	23
Major companies	59	31	19	22	27	22	27	23	24	30	24	30	25	24	25	20	21	25	23
Organized religion	35	44	24	30	40	31	35	32	28	31	52	59	20	22	23	25	23	24	25
Exec. branch of Fed. Govt	59	4	13	13	28	12	12	19	13	18	21	18	16	20	23	56	12	Ξ	10
Banks & financial																			
institutions	I	ı	32	33	42	33	32	27	24	31	21	27	27	19	18	12	15	18	25
Congress	23	17	13	4	19	13	ဝ	13	10	12	16	16	15	17	15	18	7	80	œ
Press	23	56	24	28	25	20	22	18	13	17	18	18	48	17	15	16	Ξ	∞	Ξ
	18	23	18	19	17	4	16	4	12	13	15	12	4	4	4	4	12	6	10
Organized labor	15	18	10	12	15	7	15	12	ω	∞	∞	10	9	6	Ξ	Ξ	∞	9	Ξ
Sample size	1,504	1,484	1,490 1	. 66	1,530 1	1,532 1	1,468 1	1,506 1	1,599	686	1,470 1	1,466	997 1	1,035	899 1	1,017	1,057	2,011	1,925
7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1																			

^{– =} not asked

NOTES: Percentages represent those respondents expressing a "great deal of confidence" when asked the following: "I am going to name some institutions in this country. As far as the people running these institutions are concerned, would you say that you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?" Survey was not conducted in 1979 and 1981, and the question was not asked in 1985.

^aAverage does not include banks and financial institutions.

SOURCE: J.A. Davis and T.W. Smith, General Social Surveys, Cumulative Codebook (Chicago: University of Chicago, National Opinion Research Center, annual series).

See figure 7-12.

Appendix table 7-20. Public assessments of scientific research, by selected characteristics: 1979-97

Characteristic	1979	1981	1985	1988	1990	1992	1995	1997
		Perce	ntages					
All adults								
Benefits strongly outweigh harmful results	46	42	44	57	47	42	43	47
Benefits slightly outweigh harmful results	24	28	24	25	25	31	29	28
Benefits equal harmful results	19	13	13	5	15	11	16	13
Harmful results slightly outweigh benefits	7	12	13	9	10	12	10	8
Harmful results strongly outweigh benefits	4	5	6	4	3	4	3	4
Male								
Benefits strongly outweigh harmful results	51	48	48	59	54	45	47	52
Benefits slightly outweigh harmful results	23	27	23	25	24	30	28	27
Benefits equal harmful results	16	11	10	5	9	9	13	10
Harmful results slightly outweigh benefits	7	10	13	7	9	11	9	7
Harmful results strongly outweigh benefits	3	5	6	4	4	5	4	
Female								
Benefits strongly outweigh harmful results	42	37	40	55	40	40	39	42
Benefits slightly outweigh harmful results	25	28	26	25	26	31	30	29
Benefits equal harmful results	23	16	14	6	20	13	19	15
Harmful results slightly outweigh benefits	6	14	14	10	11	12	10	10
Harmful results strongly outweigh benefits	4	5	6	4	3	4	3	4
Less than high school graduate	·	_	_	•		•		·
Benefits strongly outweigh harmful results	26	26	20	37	24	24	18	30
Benefits slightly outweigh harmful results	25	23	21	30	25	33	30	28
Benefits equal harmful results	32	25	26	9	30	17	34	21
Harmful results slightly outweigh benefits	12	18	20	17	17	20	14	18
Harmful results strongly outweigh benefits	5	9	13	7	4	7	3	3
High school graduate	Ū	Ü	.0	•	•	•	Ü	J
Benefits strongly outweigh harmful results	50	43	47	59	49	41	44	46
Benefits slightly outweigh harmful results	26	31	26	25	27	32	30	30
Benefits equal harmful results	16	10	10	5	11	10	13	13
Harmful results slightly outweigh benefits	5	12	13	7	10	12	10	6
Harmful results strongly outweigh benefits	3	4	4	4	3	5	3	5
Baccalaureate or higher degree	3	4	4	4	0	3	3	3
Benefits strongly outweigh harmful results	69	64	67	80	72	66	67	67
Benefits slightly outweigh harmful results	18	22	23	16	18	22	23	23
Benefits equal harmful results	8	7	23	1	6	8	6	6
Harmful results slightly outweigh benefits	2	4	6	2	2	3	3	3
Harmful results strongly outweigh benefits	3	2	2	1	2	2	1	1
Attentive public for science and technology	3	2	2	'	2	2	ı	1
Benefits strongly outweigh harmful results	67	63	59	62	61	48	64	64
	16	20	17	23	19	27	21	19
Benefits slightly outweigh harmful results								
Benefits equal harmful results	8 4	5 8	7 13	6 6	10 6	12 9	8 3	6 8
Harmful results slightly outweigh benefits Harmful results strongly outweigh benefits	5	4	4	3	4	4	4	
namuli results strongly outweigh benefits	5		le size	3	4	4	4	3
All adults	1,635	1,536	2,005	975	2,033	997	2,006	2,000
Male	773	724	950	475	2,033 964	464	953	930
Female	862	812	1,054	500	1,070	533	1,053	1,070
Less than high school graduate			507	259	495		418	420
High school graduate	465 932	385 886	507 1,147	259 546	495 1,202	215 579	1,196	420 1,188
							•	392
ŭ ŭ								288
Baccalaureate or higher degree Attentive public for science and technology ^a	238 154	264 381	349 235	170 116	336 229	203 94	392 195	

NOTES: Responses are for the following statements: "People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of harmful results or only slightly?" Percentages may not total 100 because of rounding.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

Appendix table 7-21. Public assessments of nuclear power, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Percentages				
All adults						
Benefits strongly outweigh harmful results	28	18	24	17	21	22
Benefits slightly outweigh harmful results	22	24	23	30	22	23
Benefits equal harmful results	6	11	12	11	14	18
Harmful results slightly outweigh benefits	13	17	13	15	21	17
Harmful results strongly outweigh benefits	31	30	28	27	21	20
Male						
Benefits strongly outweigh harmful results	38	23	31	21	29	28
Benefits slightly outweigh harmful results	22	27	24	34	23	26
Benefits equal harmful results	4	7	8	7	8	13
Harmful results slightly outweigh benefits	9	15	11	10	21	13
Harmful results strongly outweigh benefits	27	28	26	28	19	20
Female						
Benefits strongly outweigh harmful results	19	14	17	14	14	17
Benefits slightly outweigh harmful results	22	21	21	27	21	20
Benefits equal harmful results	8	14	16	14	20	22
Harmful results slightly outweigh benefits	16	19	16	18	23	20
Harmful results strongly outweigh benefits	35	32	30	27	22	21
Less than high school graduate						
Benefits strongly outweigh harmful results	28	15	21	10	15	20
Benefits slightly outweigh harmful results	24	25	21	37	16	17
Benefits equal harmful results	8	17	23	11	25	25
Harmful results slightly outweigh benefits	14	19	13	13	28	21
Harmful results strongly outweigh benefits	26	24	22	29	16	17
High school graduate						
Benefits strongly outweigh harmful results	27	18	23	19	21	22
Benefits slightly outweigh harmful results	21	23	23	26	23	23
Benefits equal harmful results	6	9	9	11	13	16
Harmful results slightly outweigh benefits	13	17	14	16	21	16
Harmful results strongly outweigh benefits	33	33	31	28	23	23
Baccalaureate or higher degree						
Benefits strongly outweigh harmful results	29	22	32	19	28	25
Benefits slightly outweigh harmful results	21	25	23	34	26	26
Benefits equal harmful results	3	7	7	10	8	14
Harmful results slightly outweigh benefits	13	14	13	14	18	17
Harmful results strongly outweigh benefits	3	32	25	23	19	18
Attentive public for science and technology ^a						
Benefits strongly outweigh harmful results	35	26	30	24	28	25
Benefits slightly outweigh harmful results	20	24	27	30	24	25
Benefits equal harmful results	1	9	6	10	10	11
Harmful results slightly outweigh benefits	12	16	9	9	22	17
Harmful results strongly outweigh benefits	32	25	28	27	18	22

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Appendix table 7-21. Public assessments of nuclear power, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Sample size				
All adults	2,005	2,041	2,033	997	2,006	2,000
Male	950	958	964	464	953	930
Female	1,054	1,084	1,070	533	1,053	1,070
Less than high school graduate	507	530	495	215	418	420
High school graduate	1,143	1,158	1,202	579	1,196	1,188
Baccalaureate or higher degree	349	353	336	203	392	392
Attentive public for science and technology	235	233	229	94	195	288

NOTES: In 1985, 1988, 1990, 1995 and 1997, the question was worded, "In the current debate over the use of nuclear reactors to generate electricity, there is a broad agreement that there are some risks and some benefits associated with nuclear power. In your opinion, have the benefits associated with nuclear power outweighed the harmful results, or have the harmful results associated with nuclear power been greater than its benefits? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of beneficial results or only slightly? "In 1992, the question was worded, "In the current debate over the use of nuclear reactors to generate electricity, there is broad agreement that there are some costs and some benefits associated with nuclear power. In your opinion, are the costs associated with nuclear power greater than the benefits, or are the benefits associated with nuclear power greater than the costs? Would you say that the benefits have substantially exceeded the costs or only slightly exceeded the costs? Would you say that the costs substantially exceeded the benefits or only slightly exceeded the benefits?" Percentages may not total 100 because of rounding.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-14.

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Appendix table 7-22. Public assessments of genetic engineering, by selected characteristics: 1985-97

Characteristic	1985	1990	1995	1997
	Percentage	es		
All adults				
Benefits strongly outweigh harmful results	23	20	21	19
Benefits slightly outweigh harmful results	26	27	22	23
Benefits equal harmful results	12	16	22	22
Harmful results slightly outweigh benefits	14	19	23	20
Harmful results strongly outweigh benefits	25	18	12	16
Male				
Benefits strongly outweigh harmful results	26	21	24	23
Benefits slightly outweigh harmful results	28	31	22	26
Benefits equal harmful results	11	14	21	20
Harmful results slightly outweigh benefits	13	18	22	17
Harmful results strongly outweigh benefits	22	16	10	14
Female				
Benefits strongly outweigh harmful results	19	19	18	16
Benefits slightly outweigh harmful results	25	23	22	21
Benefits equal harmful results	14	17	22	23
Harmful results slightly outweigh benefits	15	21	23	22
Harmful results strongly outweigh benefits	27	20	15	18
Less than high school graduate				
Benefits strongly outweigh harmful results	19	16	10	15
Benefits slightly outweigh harmful results	29	27	19	18
Benefits equal harmful results	16	25	30	23
Harmful results slightly outweigh benefits	12	17	29	30
Harmful results strongly outweigh benefits	24	15	13	14
High school graduate	27	10	10	
Benefits strongly outweigh harmful results	21	19	20	18
Benefits slightly outweigh harmful results	24	27	21	24
Benefits equal harmful results	13	12	21	21
Harmful results slightly outweigh benefits	15	21	23	18
Harmful results strongly outweigh benefits	27	21	14	19
Baccalaureate or higher degree	21	21	14	19
Benefits strongly outweigh harmful results	33	29	35	27
Benefits slightly outweigh harmful results	29	28	30	28
Benefits equal harmful results	7	15	16	21
•	13	15	14	14
Harmful results slightly outweigh benefits	18	13	6	10
Harmful results strongly outweigh benefits	10	13	O	10
Attentive public for science and technology	0.7	20	40	26
Benefits strongly outweigh harmful results	37	32	42	36
Benefits slightly outweigh harmful results	28	30	22	24
Benefits equal harmful results	9	9	16	13
Harmful results slightly outweigh benefits	12	12	13	16
Harmful results strongly outweigh benefits	14	17	7	11
Attentive public for medical research	00	0.4	0.4	07
Benefits strongly outweigh harmful results	29	31	34	27
Benefits slightly outweigh harmful results	24	27	21	25
Benefits equal harmful results	12	12	17	18
Harmful results slightly outweigh benefits	11	17	18	18
Harmful results strongly outweigh benefits	24	13	9	12

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Appendix table 7-22.

Public assessments of genetic engineering, by selected characteristics: 1985-97

Characteristic	1985	1990	1995	1997
	Sample si	ze		
All adults	2,005	2,033	2,006	2,000
Male	950	964	953	930
Female	1,054	1,070	1,053	1,070
Less than high school graduate	507	495	418	420
High school graduate	1,143	1,179	1,196	1,188
Baccalaureate or higher degree Attentive public for science and	349	359	392	392
technology	235	229	195	288
Attentive public for medical research	349	337	310	377

NOTES: In 1985, the question was worded, "Some persons have argued that the creation of new life forms through genetic engineering constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, are the risks of genetic engineering greater than the benefits, or are the benefits of genetic engineering research greater than the risks? Would you say that the benefits are substantially greater than the risks, or only slightly greater than the risks? Would you say that the risks are substantially greater than the benefits or only slightly greater than the benefits?" In 1990, the question was worded, "Some persons have argued that the creation of new life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, are the risks of genetic engineering research greater than its benefits, or are the benefits of genetic engineering research greater than its risks? Would you say that the benefits have substantially exceeded the risks or only slightly exceeded the risks? Would you say that the risks have substantially exceeded the benefits or only slightly exceeded the benefits?" In 1995, the question was worded, "Some persons have argued that the creation of new life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, have the benefits of genetic engineering research outweighed the harmful results, or have the harmful results of genetic engineering research been greater than its benefits? Would you say that balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of harmful results or only slightly?" In 1997, half of the respondents were asked the question used in 1995. The other half were asked: "Some persons have argued that the modification of existing life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, have the benefits of engineering research outweighed the harmful results, or have the harmful results of genetic engineering research been greater than its benefits? Would you say that the balance has been strongly in favor of beneficial results or only slightly? Would you say that the balance has been strongly in favor of harmful results or only slightly?" Percentages may not total 100 because of rounding.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-15.

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Appendix table 7-23. Public assessments of space exploration, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Percentages				
All adults						
Benefits strongly outweigh costs	27	22	18	17	22	24
Benefits slightly outweigh costs	27	25	25	26	24	24
Benefits equal costs	7	9	9	9	8	10
Costs slightly outweigh benefits	15	18	17	22	17	17
Costs strongly outweigh benefits	24	26	31	26	28	25
Male						
Benefits strongly outweigh costs	33	28	23	33	28	31
Benefits slightly outweigh costs	31	27	26	26	25	25
Benefits equal costs	6	10	8	8	6	8
Costs slightly outweigh benefits	12	13	16	16	16	15
Costs strongly outweigh benefits	18	22	27	27	24	21
Female						
Benefits strongly outweigh costs	21	16	14	11	17	18
Benefits slightly outweigh costs	24	23	24	25	23	23
Benefits equal costs	8	9	10	11	10	12
Costs slightly outweigh benefits	17	23	17	27	18	18
Costs strongly outweigh benefits	30	29	35	26	32	29
∟ess than high school graduate					V -	
Benefits strongly outweigh costs	22	16	15	14	14	18
Benefits slightly outweigh costs	25	26	20	29	20	21
Benefits equal costs	10	9	17	12	13	16
Costs slightly outweigh benefits	17	21	16	24	21	24
Costs strongly outweigh benefits	26	29	32	21	31	21
High school graduate	20	20	OL.	21	01	
Benefits strongly outweigh costs	26	21	17	15	23	23
Benefits slightly outweigh costs	28	25	25	25	24	23
Benefits equal costs	6	9	7	9	6	9
Costs slightly outweigh benefits	14	18	17	23	17	16
Costs strongly outweigh benefits	26	27	34	28	30	29
Baccalaureate or higher degree	20	21	34	20	30	23
Benefits strongly outweigh costs	36	33	27	22	32	31
	28	26	28	26	27	29
Benefits slightly outweigh costs	6	10	7	6	8	8
Benefits equal costs		15			0 14	12
Costs slightly outweigh benefits Costs strongly outweigh benefits	13 17	16	16 22	18 28	20	20
	17	10	22	20	20	20
Attentive public for science and technology	20	00	06	00	20	11
Benefits strongly outweigh costs	39	38	26	28	32	44
Benefits slightly outweigh costs	27	28	33	26	25	22
Benefits equal costs	7	6	4	11	7	6
Costs slightly outweigh benefits	13	10	14	20	16	11
Costs strongly outweigh benefits	14	21	23	15	20	17
Attentive public for space exploration	40	40	0.0		F.0	
Benefits strongly outweigh costs	49	46	36	38	52	57
Benefits slightly outweigh costs	25	30	36	44	23	19
Benefits equal costs	8	4	3	3	4	6
Costs slightly outweigh benefits	11	7	11	6	12	10
Costs strongly outweigh benefits	7	13	14	9	9	8

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Appendix table 7-23. Public assessments of space exploration, by selected characteristics: 1985-97

Characteristic	1985	1988	1990	1992	1995	1997
		Sample size				
All adults	2,005	2,041	2,033	1,004	2,006	2000
Male	950	958	964	486	953	930
Female	1,054	1,084	1,070	533	1,053	1070
Less than high school graduate	507	530	495	215	418	420
High school graduate	1,147	1,158	1,202	623	1,196	1188
Baccalaureate or higher degree	349	353	336	203	392	392
Attentive public for science and technology	235	233	229	105	195	288
Attentive public for space exploration	184	163	123	51	99	168

NOTES: Responses are to the following questions: "Many current issues in science and technology may be viewed as a judgment of relative benefits. Thinking first about the space program, some persons have argued that the costs of the space program may have exceeded its benefits, while other people have argued that the benefits of space exploration have exceeded its costs. In your opinion, have the costs of space exploration exceeded its benefits, or have the benefits of space exploration exceeded its costs? Would you say that the benefits have substantially exceeded the costs, or only slightly exceeded the costs? Would you say that the costs have substantially exceeded the benefits?" Percentages may not total 100 because of rounding.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-16.

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Science & Engineering Indicators – 1998

Public use of various sources of information, by selected characteristics: 1997 Appendix table 7-24 (Percentages)

Characteristic	Read news- paper every day	Read at least 1 news maga- zine regularly	Watch TV news 1+hr/day	Listen to radio news 1+hr/day	Public 1 visit/yr	Public library	Read at least 1 science maga-zine/month	Watch 1+ science TV programs/month	Visit science museums 1+/year	Purci boo Any	Purchase 1+ books/yr y Science	World Wide Web 1+ hrs/wk	Sample size
All adults	46	14	89	28	70	45	15	53	09	61	31	15	2,000
Male	49	15	63	59	89	41	20	26	63	22	32	20	930
Female	43	4	72	27	72	48	Ξ	20	29	99	59	10	1,070
Formal education	7	Ć	Ċ	č	Ç	č	c	Ĺ	ć	ć	Ċ	•	000
Less than high school	14	ِ و	90	3.7	25	ري ا	ָ ת	45	34	33	ָ ת	4	420
High school graduate	44	14	29	27	71	43	4	22	64	62	31	-	1,188
Baccalaureate degree	53	22	29	27	87	89	25	22	78	82	51	35	257
Grad./professional degree	29	27	54	27	84	63	59	25	75	87	26	37	135
Science/mathematics educationa													
Low	43	10	74	26	29	33	6	48	48	48	18	4	1,112
Middle	47	18	65	34	85	22	14	99	75	20	38	19	209
High	53	22	54	27	82	63	33	62	78	98	28	38	379
Attentiveness to science & tech.													
Attentive public	62	25	20	27	78	09	4	64	89	22	44	30	288
Interested public	38	41	89	28	74	48	13	26	99	92	35	15	918
Residual public	42	Ξ	89	32	62	35	7	44	51	51	20	တ	794
Access to cable/satellite TV													
Have cable TV	49	15	89	27	72	45	15	22	62	62	31	17	1,331
Have satellite dish	52	10	64	20	20	29	21	99	22	09	32	17	26
Have neither	35	13	69	33	69	47	14	42	22	28	29	10	572
													Ī

shows?"; "Now, let me ask you about your use of museums, zoos, and similar institutions. I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during any television shows that focus primarily on science or nature? Which science or nature show do you watch most often? About how many times a month do you watch this show?"; and "On an average day, about the last year, that is, the last 12 months. If you did not visit any given place, just say none. A natural history museum—how many times did you visit it during the last year? A zoo or an aquarium—how many times NOTE: Responses are to the statements: "How often do you read a newspaper: every day, a few times a week, once a week, or less than once a week?"; "Are there any magazines that you read regularly, that is, did you visi it during the last year? A science or technology museum—how many times did you visit it during the last year? A public library—how many times did you visit it during the last year? A science or technology museum—how many times did you visit it during the last year?", "Do you watch most of the time? What magazine would that be?"; "Altogether, on an average day, about how many hours would you say that you watch television? About how many of those hours are news reports or news how many hours would you say that you listen to a radio? About how many of those hours are news reports or news shows?" PRespondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as ^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to members of the residual public for science and technolog

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figure 7-17

This category includes 79 respondents who reported that they did not watch any television.

Appendix table 7-25. Public use of information on an annual basis, by selected characteristics: 1997

		Hon	Hours/year watching/listening to	ning/listenin	g to	Cop	Copies read/year	ar	Visits/year	ear	Number borrowed/year	owed/year	
							News	Science					
Characteristic	Total T	TV	Science TV	Total radio	Radio	News- papers	maga- zines	maga- zines	Science museum	Public library	Books	Video- tapes	Sample size
All adults	1,075	432	72	944	228	196	3.0	1.7	2.2	11.0	12.1	2.0	2,000
Male	992	387	82	986	262	206	2.8	2.5	2.0	9.5	7.7	1.3	930
FemaleFormal education	1,147	471	62	906	198	186	2.8	. :	2.1	11.8	15.9	2.0	1,070
Less than high school	1,495	553	48	904	207	178	1.7	1.0	1.0	9.7	5.5	0.5	420
High school graduate	1,040	426	81	1,030	233	192	2.5	1.5	2.0	10.0	11.6	4.1	1,188
Baccalaureate degree	743	314	72	798	234	219	4.0	3.0	3.4	16.8	20.0	3.0	257
Grad./professional degree Science/math education ^a	718	335	29	584	232	238	6.2	4.0	3.3	15.9	21.1	2.2	135
Low	1,235	489	63	887	208	185	2.0	1.0	2.0	7.7	8.8	[:	1,112
Middle	973	394	86	1,138	259	200	3.3	1.5	2.9	13.2	13.3	1.6	209
High	744	317	79	820	243	220	4.6	4.1	3.3	15.3	19.9	3.0	379
Attentiveness to science and technology ^b													
Attentive public	1,093	200	102	957	254	298	6.5	5.5	3.1	16.7	18.0	2.3	288
Interested public	1,044	443	84	931	238	171	2.5	4.1	2.5	11.1	13.0	1.5	918
Residual publicAccess to cable/satellite TV	1,105	395	46	954	205	186	8.	6.0	1.7	8.0	8.8	1.0	794
Have cable TV	1,149	459	84	922	217	209	3.0	1.7	2.0	10.6	11.5	1.0	1,331
Have satellite dish	1,154	373	109	1,050	177	218	4.1	3.2	2.0	7.5	9.6	1.4	26
Have neither	888	379	35	886	261	160	2.3	1.7	2.2	11.0	13.9	2.3	572

NOTE: Responses are to the statements: "Altogether, on an average day, about how many hours would you say that you watch television? About how many of those hours are news reports or news shows?" "Now, you borrow any books from the public library? (if yes):About how many books did you borrow during the last year?" "During the last 12 months, did you borrow any videotapes from the public library? (if yes):About during the last year? A science or technology museum—how many times did you visit it during the last year? A public library—how many times did you visit it during the last year?"; "During the last 12 months, did let me ask you about your use of museums, zoos, and similar institutions. I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during the last year, that is, the last 12 months. If you did not visit any given place, just say none. A natural history museum—how many times did you visit it during the last year? A zoo or an aquarium—how many times did you visit it how many videotapes did you borrow during the last year?" "Do you watch any television shows that focus primarily on science or nature? Which science or nature show do you watch most often? About how many times a month do you watch this show?"; and "On an average day, about how many hours would you say that you listen to a radio? About how many of those hours are news reports or news shows?" *Respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer. ^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technologies. Any individual who is not attentive to either of those issues but who is a member of the interested public for at least one of those issues is classified as a member of the interested public for science and technology. All other individuals are classified as members of the residual public for science and technology

See figures 7-18 and 7-19.

^cThis category includes 79 respondents who reported that they did not watch any television.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Science Resources Studies Division.

Appendix table 7-26. Public's access to computers from work and home, by selected characteristics: 1983-97

Characteristic	1983	1985	1988	1990	1995	1997
		Percentages				
All adults						
No access	70	66	62	58	46	43
Access from work or home	27	28	29	30	33	34
Access from work and home	3	6	9	12	21	23
Male						
No access	68	62	59	55	41	42
Access from work or home	28	30	30	30	34	32
Access from work and home	4	8	11	15	25	26
Female						
No access	72	69	66	61	50	44
Access from work or home	26	26	28	31	33	36
Access from work and home	2	5	6	8	17	20
Less than high school graduate						
No access	94	87	92	85	80	79
Access from work or home	6	13	8	14	18	18
Access from work and home	0	0	0	1	2	3
High school graduate						
No access	66	65	58	55	42	40
Access from work or home	31	30	35	34	38	39
Access from work and home	3	5	7	11	20	21
Baccalaureate or higher degree						
No access	47	40	33	29	18	12
Access from work or home	45	43	41	41	36	38
Access from work and home	8	17	26	30	46	50
Attentive public for science and technology ^a						
No access	61	56	50	44	31	34
Access from work or home	29	33	35	31	31	36
Access from work and home	10	11	15	25	38	30
		Sample size				
All adults	631	2,005	2,041	2,033	2,006	2,000
Male	775	950	958	964	953	930
Female	856	1,054	1,084	1,070	1,053	1,070
Less than high school graduate	404	507	530	495	418	420
High school graduate	941	1,147	1,158	1,202	1,196	1188
Baccalaureate or higher degree	282	349	353	336	392	392
Attentive public for science and technology	208	235	233	229	195	288

NOTE: In 1985, 1988, 1990, 1995 and 1997, the question was worded, "Do you use a computer in your work? About how many hours do you personally use your work computer in a typical week? Do you presently have a home computer in your household? About how many hours do you personally use your home computer in a typical week?" In 1983, the question was worded, "Do you use computers or word processing equipment in your work?..."

SOURCES: J.D. Miller and L. Kimmel, *Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook* (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

See figures 7-20 and 8-24.

^aThe attentive public for science and technology contains the attentive public for new scientific discoveries and the attentive public for new inventions and technologies.

Public's access to and use of computers at home and work, by selected characteristics: 1997 Appendix table 7-27 (Percentages)

	Use	Have	Com-	Com-			Hor	Home computer	ıter		Work computer	mputer	 Use	Use (hours/year)	ar)
Characteristic	com- puter in work	com- puter at home	puter at home & work	puter at home or work	No com- puter	Modem	On-line service	CD- ROM	E-mail address	Access	E-mail address	Access	Work computer	Home	On-line hrs/year
All adults	38	43	23	22	43	33	18	59	18	16	16	14	369	130	59
Male	41	44	26	58	42	35	21	31	20	20	18	18	371	161	37
FemaleFormal education	32	4	50	56	44	33	15	56	15	13	4	=	368	102	22
Less than high school	9	19	က	21	26	13	-	80	9	2	-	2	31	51	4
High school graduate	33	42	21	09	40	31	17	59	17	4	12	1	390	119	56
Baccalaureate degree	29	29	47	87	13	24	35	49	31	32	40	36	969	237	09
Grad./professional degree	89	92	54	88	12	62	14	22	37	38	43	45	612	263	69
Science/math education															
Low	22	29	12	40	09	20	6	17	∞	7	2	2	221	71	12
Middle	21	23	35	72	28	42	23	38	22	22	22	18	439	162	31
High	64	89	44	88	12	99	37	51	36	36	38	35	400	257	74
Attentiveness to science and technology ^b															
Attentive public	42	54	30	99	34	47	56	40	30	30	23	23	465	225	22
Interested public	42	46	56	63	37	34	20	31	18	17	17	16	398	152	35
Residual public	31	34	18	48	25	56	13	22	13	10	12	တ	301	69	16
Access to cable/satellite TV															
Have cable TV	41	46	25	61	33	36	20	32	20	18	17	15	401	143	35
Have satellite dish	33	45	21	63	37	33	17	31	18	19	12	10	308	134	99
Have neither°	30	35	17	47	23	24	12	21	12	Ξ	12	13	306	26	20

WWW = World Wide Web

work? Do you have access to the World Wide Web through your work computer? Do you presently have a home computer in your household? About how many hours do you personally use your home computer in Online, or any other dial-in-service? About how many hours a month do you use your dial-in or network service? Do you have an e-mail address that you use with your home computer? Do you ever access the a typical week? Do you have a CD-ROM reader in your home computer? Do you have a modem in your home computer? Do you presently subscribe to any network service like CompuServe, Prodigy, America NOTE: Responses are to the statements: "Do you use a computer in your work? About how many hours do you personally use your work computer in a typical week? Do you have an e-mail address for use at World Wide Web through your home computer?" *Respondents were classified as having a "high" level of science/mathematics education if they took nine or more high school and college science/math courses. They were classified as "middle" if they took six to eight such courses, and as "low" if they took five or fewer.

^bThe attentive public for science and technology combines the attentive public for new scientific discoveries and the attentive public for new inventions and technology. All other individuals are classified as a member of the interested public for at least one of those issues is classified as a member of the interested public for at least one of those issues is classified as members of the residual public for science and technology

This category includes 79 respondents who reported that they did not watch any television.

SOURCES: J.D. Miller and L. Kimmel, Public Attitudes Toward Science and Technology, 1979-1997, Integrated Codebook (Chicago: Chicago Academy of Sciences, International Center for the Advancement of Scientific Literacy, 1997); and unpublished tabulations.

Appendix table 8-1. Uses of computers in the workplace: 1993

	Workers who us	se this application
	Number	
Application	(thousands)	Percentage
Analysis	13,018	25
Bookkeeping	13,236	26
Bulletin boards	4,315	8
Calendar scheduling	11,846	23
Communications	16,058	31
Computer-assisted design	3,856	8
Databases	17,556	34
Desktop publishing	5,933	12
Educational programs	4,689	9
E-mail	10,872	21
Games	2,930	6
Graphics	8,671	17
Inventory control	12,823	25
Invoicing	10,057	20
Learn to use	4,820	9
Programming	6,671	13
Sales	7,629	15
Spreadsheets	12,045	24
Telemarketing	1,656	3
Word processing	22,624	44
Other	9,841	19
Don't know	2,895	6
Total workers who use a computer	51,106	

 $SOURCE: U.S.\ Bureau\ of\ the\ Census,\ Current\ Population\ Survey,\ October\ 1993.\ Available\ from\ << http://www.census.gov/population/socdemo/computer/compusea/text>>.$

Appendix table 8-2. Index of real net information technologies capital stock in the private sector: 1960-95

	Office, computing, and accounting machinery	Communications equipment	All nonresidential durable equipment
1960	0.23	8.15	25.62
1961	0.24	9.27	26.18
1962	0.25	10.56	27.06
1963	0.29	11.56	28.12
1964	0.34	12.50	29.56
1965	0.40	13.69	31.67
1966	0.53	15.09	34.26
1967	0.65	16.46	36.44
1968	0.76	17.84	38.76
1969	0.93	19.64	41.32
1970	1.09	21.64	43.32
1971	1.28	23.25	45.08
1972	1.57	24.52	47.46
1973	1.90	26.43	50.92
1974	2.34	28.26	54.11
1975	2.64	29.63	55.89
1976	3.12	31.22	57.88
1977	3.78	34.23	60.81
1978	5.33	38.13	64.75
1979	7.57	43.01	68.95
1980	10.48	48.46	71.95
1981	14.25	53.71	74.76
1982	17.19	58.50	76.22
1983	22.87	62.70	77.86
1984	32.03	67.54	81.11
1985	41.88	72.67	84.45
1986	51.55	77.58	87.32
1987	59.61	81.59	89.63
1988	66.84	86.52	92.30
1989	75.82	90.75	95.03
1990	81.69	94.58	97.22
1991	87.31	97.21	98.39
1992	100.00	100.00	100.00
1993	119.03	102.20	102.72
1994	143.14	106.43	106.90
1995	178.09	112.78	111.89

NOTE: Index is chain-link index; values are expressed relative to 1992 dollars.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business (May 1997), table 4, pp. 82-84.

See figure 8-2.

Appendix table 8-3. Gross product by industry as a share of gross domestic product: 1959-94, selected years (Percentages)

Industry	1959	1967	1977	1982	1987	1988	1989	1990	1991	1992	1993	1994
Goods, total	38.9	36.0	32.8	31.0	27.3	27.6	26.8	26.2	24.7	24.0	23.7	24.2
Agriculture, forestry, and fishing	4.0	3.0	2.7	2.4	1.9	1.8	1.9	1.9	1.7	1.8	1.6	1.7
Mining	2.5	1.8	2.7	4.6	1.9	2.0	1.8	2.0	1.7	1.5	1.4	1.3
Construction	4.7	4.7	4.6	4.0	4.6	4.6	4.5	4.3	3.9	3.7	3.7	3.9
Manufacturing	27.7	26.5	22.8	20.0	18.9	19.2	18.6	18.0	17.4	17.0	17.0	17.3
Services, total	48.8	49.8	51.9	53.9	59.1	59.7	59.6	59.8	61.0	61.3	61.6	62.0
Transportation and public utilities ^a	8.9	8.5	8.9	0.6	9.0	8.8	8.5	8.4	8.7	8.5	8.6	8.7
Wholesale trade	7.1	6.9	7.0	6.8	6.4	6.7	9.9	6.4	9.9	6.5	6.5	6.7
Retail trade	9.7	9.4	9.4	8.9	9.3	9.1	0.6	8.8	8.7	8.7	8.7	8.8
Finance, insurance, and real estate	13.6	14.1	14.0	15.6	17.7	17.7	17.7	17.8	18.3	18.4	18.5	18.4
Professional ^b	5.2	6.5	8.6	10.6	12.5	10.8	11.0	11.5	11.7	12.1	12.2	12.3
Personal ^c	3.4	3.5	3.1	3.1	3.4	3.5	3.4	3.6	3.5	3.6	3.5	3.6
Other ^d	6.0	6.0	0.8	0.8	6.0	3.2	3.7	3.6	3.4	3.5	3.5	3.6
Government	12.8	14.1	14.5	14.2	13.9	13.8	13.6	13.8	14.2	14.0	13.7	13.4

NOTE: Shares are based on current dollars.

^aThis includes communications.

Professional services include business, health, legal, educational, social, and (through 1987) miscellaneous professional services.

Personal services include hotels and lodging, personal, auto repair and services, miscellaneous repair, amusement and recreation, and private household services.

^dOther services include motion pictures, membership organizations, and (after 1987) other.

SOURCE: U.S. Bureau of Economic Analysis, Survey of Current Business (August 1996), table 11.

See figures 8-6 and 8-7.

Appendix table 8-4. **U.S. employment by industrial sector: 1950-90, selected years** (Percentages)

Industry	1950	1960	1970	1980	1990
Total	100.0	100.0	100.0	100.0	100.0
Extractive	14.4	8.1	4.6	4.5	3.5
Agriculture	12.7	7.0	3.7	3.6	2.8
Mining	1.7	1.1	0.8	1.0	0.6
Transformative	33.9	35.9	33.0	29.6	25.6
Constructive	6.2	6.2	6.0	6.2	6.5
Utilities	1.4	1.4	1.1	1.2	1.1
Manufacturing	26.2	28.3	25.9	22.2	18.0
Food	2.7	3.1	1.9	1.9	1.6
Textiles	2.2	3.3	1.3	0.8	0.6
Metal	3.6	3.9	3.1	2.7	1.8
Machinery	3.7	7.5	5.1	5.2	3.8
Chemical	1.7	1.8	1.5	1.6	1.3
Miscellaneous manufacturing	12.3	8.7	12.9	10.0	8.9
Distributive services	22.4	21.9	22.4	21.0	20.6
Transportation	5.3	4.4	3.9	3.7	3.5
Communication	1.2	1.3	1.5	1.5	1.3
Wholesale	3.5	3.6	4.0	3.9	3.9
Retail	12.3	12.5	12.9	11.9	11.8
Producer services	4.8	6.6	8.2	10.5	14.0
Banking	1.1	1.6	2.2	2.6	2.9
Insurance	1.4	1.7	1.8	1.9	2.1
Real estate	1.0	1.0	1.0	1.6	1.8
Engineering	0.2	0.3	0.4	0.6	0.7
Accounting	0.2	0.3	0.4	0.5	0.5
Miscellaneous business services	0.2	1.2	1.8	2.6	4.9
Legal services	0.6	0.5	0.5	0.8	1.0
Social services	12.4	16.3	22.0	23.7	24.9
	1.1	10.3	22.0	23.7	24.9 4.3
Medical, health services			3.7	2.3 5.3	
Hospital	1.8 3.8	2.7 5.4	3.7 8.5	5.3 8.3	4.0 7.9
Education			6.5 1.2		
Welfare, religious services	0.7	1.0		1.6	2.6
Nonprofit organization	0.3	0.4	0.4	0.5	0.4
Postal service	0.8	0.9	1.0	0.7	0.7
Government	3.7	4.3	4.5	4.7	4.8
Miscellaneous social services	0.1	0.2	0.3	0.4	0.2
Personal services	12.1	11.3	10.0	10.5	11.5
Domestic services	3.2	3.1	1.7	1.3	0.9
Hotel	1.0	1.0	1.0	1.1	1.5
Eating, drinking places	3.0	2.9	3.2	4.4	4.8
Repair services	1.7	1.4	1.4	1.3	1.4
Laundry	1.2	1.0	0.8	0.4	0.5
Barber, beauty shops	_	0.8	0.9	0.7	0.7
Entertainment	1.0	0.8	0.8	1.0	1.3
Miscellaneous personal services	1.2	0.4	0.3	0.3	0.4

NOTE: Details may not add to totals because of rounding.

SOURCE: M. Castells, The Rise of the Network Society (Cambridge, MA: Basil Blackwell, 1996).

See figure 8-8.

Appendix table 8-5. Workers who use a computer at work, by sector: 1993

	Total employed in	who use a	in sector computer
Sector	sector (thousands)	Number (thousands)	Percentage
Government	5,927	4,137	70
All industries	118,400	51,106	43
Agriculture	3,140	435	14
Mining	689	307	45
Construction	7,567	1,182	16
Manufacturing, total	19,605	8,178	42
Food	1,776	532	30
Tobacco	52	25	48
Apparel	970	143	15
Textiles	664	177	27
Leather and leather products	107	24	22
Lumber and wood	841	114	14
Furniture	665	161	24
Paper and allied products	740	339	46
Printing and publishing	1,705	857	50
Chemicals	1,220	729	60
Petroleum and coal	145	88	61
Rubber and plastics	791	293	37
Stone, clay, and glass	568	165	29
Primary metals	653	217	33
Fabricated metals	1,290	442	34
Non-electric machinery	2,238	1,233	55
Electric machinery	1,689	950	56
Motor vehicles	1,120	428	38
Aircraft	502	335	67
Other transportation	624	376	60
Photo equipment	680	406	60
Toys and sporting goods	128	44	34
Miscellaneous manufactures	437	100	23
Services, total	81,473	36,867	45
Transportation	5,410	1,866	34
Communications	1,637	1,283	78
Utilities	1,501	807	54
Wholesale trade	4,531	2,226	49
Retail trade	18,706	5,837	31
Banking and finance	3,417	2,888	85
Insurance and real estate	4,561	3,094	68
Professional services	31,020	16,515	53
Personal services	10,690	2,351	22
Business services	5,038	2,646	53
	5,000	2,040	

SOURCE: U.S. Bureau of the Census, Current Population Survey, October 1993. Available from <">http://www.census.gov/population/socdemo/computer/compusea/text>>>.

See figure 8-9.

Appendix table 8-6. Index of information technologies investments, by industry: 1991-92

Industry	Industry's share of GDP, 1992 (%)	Industry's IT investments 1991 (\$ billion)	Industry's share of IT investments (%)	Investment Index
Manufacturing	17.0	25.30	16.6	0.98
Transportation	3.1	3.80	2.5	0.81
Communications	2.6	21.10	13.9	5.35
Utilities	2.8	8.00	5.3	1.89
Wholesale trade	6.5	17.00	11.2	1.72
Retail trade	8.7	17.90	11.8	1.36
Finance, insurance, and real estate	18.4	38.70	25.4	1.38
Professional and personal services	19.2	20.30	13.3	0.69

IT = information technologies

NOTE: Investment Index equals industry's share of IT investments divided by industry's share of GDP. An index of 1.00 reflects no over- or under-investing in IT relative to the size of the industry.

SOURCES: Industry investments from National Research Council, *Information Technology in the Service Society* (Washington, DC: National Academy Press, 1994), p. 2; share of GDP from U.S. Bureau of Economic Analysis, *Survey of Current Business* (August 1996), p. 137.

See figure 8-10.

Appendix table 8-7. **Technology in public schools: 1992-95**

		Nur	mber		Percenta	ge of total
Technology	1992	1993	1994	1995	1992	1995
Schools with interactive videodisk players ^a	6,502	11,729	19,189	23,112	8	27
Elementary	2,921	5,986	10,043	12,326	6	24
Junior high	1,258	2,386	3,844	4,672	10	34
Senior high	2,106	3,129	5,026	5,805	14	34
Students represented (1,000)	5,781	9,064	13,434	16,060	14	36
Schools with modems ^a	13,597	18,471	24,277	28,275	16	34
Elementary	5,831	8,492	11,679	14,782	11	29
Junior high	2,608	3,431	4,531	5,393	20	39
Senior high	5,001	6,371	7,853	8,620	30	51
Students represented (1,000)	10,717	13,382	16,476	19,326	25	43
Schools with networks ^a	4,184	11,657	19,272	23,402	5	28
Elementary	1,583	4,683	8,477	11,155	3	22
Junior high	776	2,030	3,611	4,425	6	32
Senior high	1,736	4,895	7,104	8,042	10	48
Students represented (1,000)	3,754	8,043	12,713	15,160	9	34
Schools with CD-ROMs ^a	5,706	11,021	24,526	31,501	7	37
Elementary	1,897	4,457	11,794	16,816	4	33
Junior high	1,231	2,326	4,874	6,170	9	45
Senior high	2,543	4,168	7,724	9,063	15	64
Students represented (1,000)	5,298	8,534	15,576	19,501	12	44
Schools with satellite dishesa	1,129	8,812	12,580	14,290	1	17
Elementary	351	2,988	4,269	5,154	1	10
Junior high	166	1,503	2,497	3,004	1	22
Senior high	606	4,292	5,770	6,263	4	37
Students represented (1,000)	1,906	4,668	6,740	7,946	4	18
Schools with cable ^a	NA	47,745	58,652	62,593	NA	74
Elementary	NA	27,923	35,325	37,730	NA	73
Junior high	NA	9,266	10,696	11,416	NA	83
Senior high	NA	10,296	12,198	13,089	NA	78
Students represented (1,000)	NA	27,324	33,510	35,770	NA	80

NA = not available

NOTE: Elementary includes K-12; preschool, preschool through 8, K-6, and K-8. Junior high includes schools with grade spans of 4-6, 7-8, and 7-9. Senior high includes 7-12, 9-12, 10-12, vocational, technical, and alternative high schools.

SOURCE: U.S. Bureau of the Census, Statistical Abstract of the United States 1996, table 264 (Washington, DC: U.S. Government Printing Office, 1996); data based on surveys conducted by Quality Education Data, Inc.

^aIncludes schools for special education and adult education not shown separately.

Appendix table 8-8. Student use of computers at home and at school, by sex, race/ethnicity, and household income: 1984 and 1993 (Percentages)

		_			1993		
Characteristic	1984 total	Total	Pre-K and K	Grades 1-8	Grades 9-12	1st to 4th year of college	5th or later year college
		Computer u	se at school				
Total	27.3	59.0	26.2	68.9	58.2	55.2	52.1
Sex							
Male	29.0	59.4	25.9	69.5	56.5	57.5	56.7
Female	25.5	58.7	26.5	68.4	60.0	53.3	47.8
Race/ethnicity							
White	30.0	61.6	29.4	73.7	59.9	54.9	59.8
Black	16.8	51.5	16.5	56.5	54.5	56.9	57.9
Hispanic	18.6	52.3	19.2	58.4	54.1	51.9	53.7
Other	28.6	59.0	23.5	65.7	57.3	60.9	69.4
Household income							
Less than \$5,000	18.7	51.2	19.6	55.0	50.6	61.7	66.7
\$5,000 to \$9,999	21.0	53.3	24.4	60.3	51.9	53.9	56.2
\$10,000 to \$14,999	22.4	56.4	20.1	64.7	56.7	50.7	76.1
\$15,000 to \$19,999	25.9	58.1	23.8	67.5	57.4	51.2	58.5
\$20,000 to \$24,999	26.7	56.4	23.7	64.3	53.0	57.4	52.4
\$25,000 to \$29,999	30.5	60.0	28.0	70.1	60.3	51.5	58.0
\$30,000 to \$34,999	30.5	59.1	23.7	69.6	59.7	51.7	45.3
\$35,000 to \$39,999	32.3	60.7	27.1	72.1	61.7	49.2	47.9
\$40,000 to \$49,999	32.8	59.3	28.5	70.3	57.2	53.9	48.6
\$50,000 to \$74,999	35.5	62.6	28.6	75.6	61.5	57.4	44.2
\$75,000 or more	36.0	64.6	33.5	78.7	62.5	60.9	44.2 47.7
	30.0	04.0	33.3	10.1	02.5	60.9	47.7
Institution type Public	27.4	60.2	20.1	68.6	58.1	53.9	54.1
		60.2	30.1				
Private	26.5	52.1	18.7	72.5	60.7	60.7	48.0
Tatal	44.5	•	use at home	04.7	00.7	00.0	
Total	11.5	27.0	15.6	24.7	28.7	32.8	52.6
Sex							
Male	14.0	27.4	15.1	24.8	28.2	36.6	56.1
Female	9.0	26.6	16.1	24.6	29.2	29.7	49.5
Race/ethnicity							
White	13.7	32.8	19.4	31.4	35.9	36.0	53.6
Black	4.9	10.9	4.2	9.0	10.4	19.4	48.1
Hispanic	3.6	10.4	5.7	7.5	9.8	22.0	52.2
Other	9.0	28.7	17.0	23.2	37.0	33.0	47.1
Household income							
Less than \$5,000	2.9	9.7	1.1	4.1	6.8	25.6	45.2
\$5,000 to \$9,999	3.2	8.0	0.9	4.5	5.3	21.3	45.6
\$10,000 to \$14,999	5.0	11.4	4.6	6.4	8.7	29.8	50.0
\$15,000 to \$19,999	7.5	15.1	6.9	10.9	14.1	28.9	43.0
\$20,000 to \$24,999	9.9	16.8	7.4	13.1	17.9	27.7	49.6
\$25,000 to \$29,999	12.8	21.1	12.3	19.3	22.0	26.1	47.0
\$30,000 to \$34,999	15.8	24.1	18.7	20.5	29.1	26.4	44.4
\$35,000 to \$39,999	19.4	27.1	13.0	26.3	28.1	32.7	52.7
\$40,000 to \$49,999	20.4	32.2	21.6	32.9	33.9	32.5	45.9
\$50,000 to \$74,999	24.2	43.0	25.5	45.3	46.4	40.1	58.2
\$75,000 or more	22.1	56.1	38.2	62.3	61.0	47.0	64.7
Institution type							
Public	11.2	25.3	12.1	23.0	27.2	31.9	50.0
Private	13.8	37.4	22.4	41.5	47.2	36.9	57.7

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Appendix table 8-8. Student use of computers at home and at school, by sex, race/ethnicity, and household income: 1984 and 1993 (Percentages)

					1993		
Characteristic	1984 total	Total	Pre-K and K	Grades 1-8	Grades 9-12	1st to 4th year of college	5th or later year of college
	Comp	uter use at ho	me for schoo	ol work			
Total	4.6	14.9	0.6	10.8	20.9	23.1	36.6
Sex							
Male	5.9	14.8	0.9	10.1	20.5	26.3	40.3
Female	3.3	15.0	0.4	11.5	21.4	20.5	33.2
Race/ethnicity							
White	5.4	18.2	0.8	13.8	26.5	25.7	37.8
Black	2.3	5.7	NA	4.0	6.9	11.5	30.1
Hispanic	1.4	5.6	NA	2.9	6.7	15.9	36.8
Other	3.8	16.0	1.1	9.3	27.0	23.7	29.2
Household income							
Less than \$5,000	1.0	6.7	NA	2.5	4.0	18.7	36.0
\$5,000 to \$9,999	1.5	4.8	NA	1.1	3.6	16.1	35.5
\$10,000 to \$14,999	1.9	7.3	NA	2.6	5.6	25.9	34.6
\$15,000 to \$19,999	3.0	8.6	0.4	4.7	10.8	18.7	31.0
\$20,000 to \$24,999	3.1	9.8	0.7	5.1	12.6	22.9	35.0
\$25,000 to \$29,999	5.1	10.4	1.1	6.3	13.4	19.5	34.9
\$30,000 to \$34,999	4.9	13.0	0.8	8.1	21.9	18.0	35.1
\$35,000 to \$39,999	7.1	15.4	0.8	12.4	21.0	22.6	37.2
\$40,000 to \$49,999	9.2	17.1	1.1	14.7	24.2	22.2	32.1
\$50,000 to \$74,999	11.5	23.2	1.0	19.7	35.0	27.0	38.2
\$75,000 or more	9.8	30.4	0.8	29.4	45.2	30.6	41.5
Institution type							
Public	4.5	14.2	0.5	10.1	19.8	22.7	34.7
Private	5.4	18.8	1.0	17.8	35.4	24.8	40.1

Pre-K and K = prekindergarten and kindergarten

SOURCE: U.S. Bureau of the Census, *Statistical Abstract of the United States, 1996,* table 263 (Washington, DC: U.S. Government Printing Office, 1996). See figures 8-19 and 8-21.

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Appendix table 8-9. Adult use of computers at home, school, and work: 1993 (Percentages)

Characteristic	Uses computer anywhere	Has computer at home	Has computer at home and uses computer at home	Enrolled in school and uses computer at school	Has a job and uses computer at work
Age					
Persons over 18	36.0	25.6	65.6	53.8	45.8
18-21 years	45.9	30.4	62.5	62.3	25.8
22-24 years	43.5	25.4	68.9	53.1	42.1
25-34 years	44.4	25.3	73.8	45.2	49.1
35-44 years	46.7	34.2	68.4	43.0	50.8
45-54 years	43.8	34.4	64.0	40.4	49.8
55-64 years	24.2	19.9	55.9	31.9	37.3
65+ years	4.9	8.4	41.2	36.0	20.3
Race	4.5	0.4	41.2	30.0	20.0
White	37.5	26.9	66.7	53.1	47.1
Black	25.0	13.8	56.8	54.8	36.1
Other	35.6	31.3	55.8	60.3	42.3
Hispanic origin	00.0	10.0	64.0	E0.0	00.0
Hispanic	22.0	12.9	61.3	50.0	29.3
Not Hispanic	37.2	26.7	65.8	54.1	47.2
Sex		a= .			
Male	36.2	27.1	70.0	55.9	40.3
Female	35.8	24.3	61.1	51.9	52.4
Marital status					
Married	37.5	29.4	65.3	40.5	48.2
Single	42.5	25.3	68.8	58.9	41.2
Divorced/widowed	23.7	14.0	61.3	45.8	43.1
Uses computer					
At work	100.0	43.2	79.4	48.9	100.0
At home	100.0	100.0	NA	55.9	73.0
Household type					
Married couple	38.6	30.4	64.4	54.2	46.8
Female householder	29.2	14.1	65.0	51.4	45.9
Male householder	33.8	20.0	76.5	55.4	41.2
Region					
Northeast	34.3	25.6	62.2	56.4	46.0
Midwest	37.2	25.1	64.9	30.0	45.8
South	33.8	22.1	65.3	51.8	44.3
West	39.6	31.8	69.3	47.3	48.2
Educational attainment					
Less than 9th grade	1.5	4.5	12.7	31.1	4.0
9th-11th grade	9.8	8.1	41.8	46.6	13.0
High school graduate	25.1	16.7	49.3	51.7	34.2
Some college/associate's degree	50.5	33.1	67.9	56.3	52.6
Bachelor's +	63.4	48.7	76.9	50.5	69.1
Employment	00. ⊣	40.7	70.0	00.0	00.1
Employed	49.8	30.8	66.5	43.6	43.2
Full time	51.4	30.6	69.4	37.6	49.6
Part time	41.9	31.4	68.0	57.5	28.1
		22.1	67.0		NA
Unemployed	17.5			51.0	
Not in labor force	11.5	16.1	52.1	62.9	NA
	20.0	22.0	60.6	NI A	<i>15 5</i>
Not enrolled	32.8	23.9	63.6	NA 46.2	45.5
Below college	47.9	22.0	71.8	46.3	11.9
College	74.7	47.4	77.7	54.6	53.0

Appendix table 8-9. **Adult use of computers at home, school, and work: 1993**(Percentages)

Characteristic	Uses computer anywhere	Has computer at home	Has computer at home and uses computer at home	Enrolled in school and uses computer at school	Has a job and uses computer at work
Family income					
Less than \$10,000	11.4	6.8	68.6	53.6	18.3
\$10,000-\$14,999	15.2	8.4	64.8	55.3	23.7
\$15,000-\$19,999	23.0	12.5	62.4	50.9	31.7
\$20,000-\$24,999	27.7	15.3	62.3	56.6	36.0
\$25,000-\$34,999	36.5	21.2	64.3	50.9	42.8
\$35,000-\$49,999	46.3	31.3	55.4	51.0	50.6
\$50,000-\$74,999	60.3	45.9	67.1	54.4	61.5
\$75,000 and over	65.4	61.7	68.0	58.8	67.0
Income not reported	24.4	20.2	57.2	53.3	39.5
Household size					
1-3 persons	33.7	21.2	69.6	51.9	47.5
4-5 persons	43.1	35.8	62.1	56.0	45.0
6-7 persons	30.4	28.6	52.3	56.2	33.7
8+ persons	17.6	22.1	48.3	49.8	19.5
Occupation					
Management and professional	69.6	47.9	77.0	46.7	67.7
Technical, sales, administration	63.6	31.6	69.2	50.7	65.5
Service	22.4	18.6	54.9	53.5	14.7
Precision, production, craft	26.0	21.6	56.8	44.0	23.2
Operators, labor	18.8	15.2	51.9	47.0	14.9
Farm, forest, fish	14.7	16.7	59.5	62.5	8.5
Never work/NILF/AF	10.7	15.4	50.9	61.8	NA
Industry			00.0	00	
Agriculture	19.1	19.9	64.9	51.3	13.5
Mining	44.7	30.7	64.0	(B)	46.1
Construction	20.2	21.4	57.3	49.1	16.8
Manufacturing	43.0	27.3	69.4	48.6	44.0
Transportation, communications, utilities	48.8	29.9	63.6	46.5	49.4
Wholesale/retail	40.8	25.4	61.8	53.1	37.0
Finance, insurance	74.6	36.0	72.4	38.4	79.3
Services	51.2	35.2	72.6	51.2	48.0
Forest/fisheries	36.1	28.8	(B)	(B)	35.2
Public administrator	70.6	34.1	74.0	32.2	73.7
Never work/NILF/AF	10.7	15.4	50.9	61.8	NA

AF = armed forces; (B) = less than 75,000 persons or 50 sample cases; NA = not applicable; NILF = not in labor force

NOTES: Persons of Hispanic origin may be of any race. The term "uses computer anywhere" means that the individual uses computer at home, at school, and/or at work; the term "with computer at home" means that there is a computer in the household.

SOURCE: U.S. Bureau of the Census, Current Population Survey, October 1993. Available from <http://www.census.gov/population/socdemo/computer/compusea/text.

See figures 8-23 and 8-25.

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Appendix table 8-10.

Commercial banks output per employee: 1967-95

Year	Index	Year	Index
1967	71.2	1981	78.7
1968	72.5	1982	81.0
1969	71.5	1983	87.6
1970	72.3	1984	90.7
1971	75.1	1985	94.6
1972	76.9	1986	97.0
1973	81.7	1987	100.0
1974	76.9	1988	101.4
1975	77.2	1989	99.6
1976	81.4	1990	102.6
1977	85.9	1991	104.5
1978	86.8	1992	106.4
1979	84.5	1993	115.5
1980	78.8	1994	115.8
		1995	121.7

NOTES: Commercial banks are Standard Industrial Classification code 602. Industry Productivity Index: 1987 = 100.

SOURCE: U.S. Bureau of Labor Statistics, Industry Productivity Index, <">http://stats.bls.gov/cgi-bin/dsrv>> (data extracted July 1997).">extracted July 1997).

See figure 8-12.

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